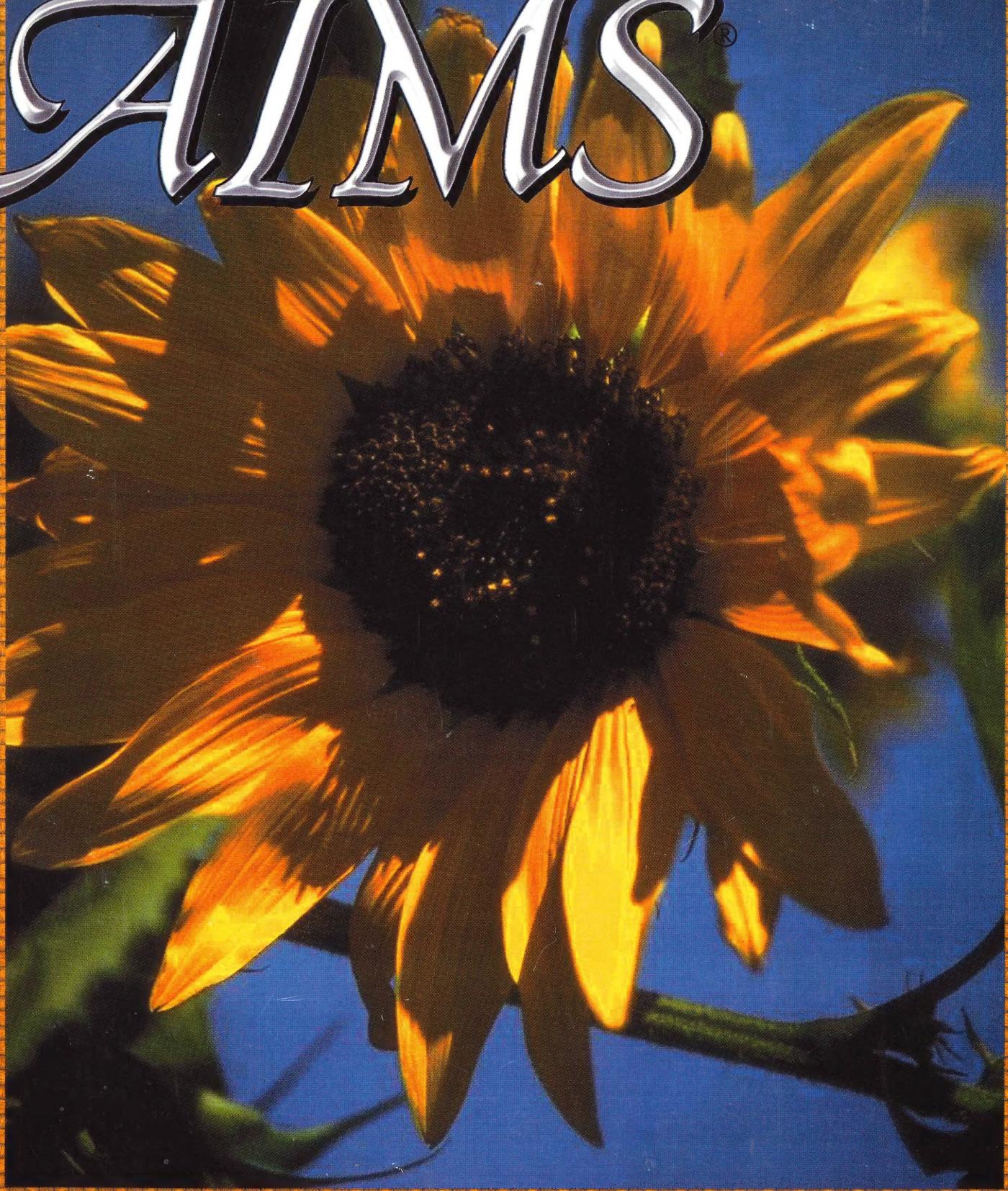


# ADS®



Volume XVII  
Number 1  
July/August 2002

The AIMS Education Foundation is a research and development organization dedicated to the improvement of the teaching and learning of mathematics and science through a meaningful integrated approach.

# AIMS®

AIMS is published 10 times a year by the AIMS Education Foundation, a not-for-profit corporation located at 1595 South Chestnut Avenue, Fresno, CA 93702-4706. Send address changes to P.O. Box 8120, Fresno, CA 93747-8120. Phone (888) 733-2467, Fax (559) 255-6396. Web Page: <http://www.aimsedu.org>  
E-mail: [aimsed@fresno.edu](mailto:aimsed@fresno.edu)

#### AIMS Magazine Staff

*Managing Editor:* Betty Cordel

*Assistant Editor:* Michelle Pauls

*Staff Artists:* Dawn DonDiego, Broc Heasley, Reneé Mason, Margo Pocock, David Schlotterback, Brenda Wood

*Desktop Publishing:* Tracey Lieder, Roxanne Williams

#### AIMS Center for Research and Development

##### *Program Directors*

Judith Hillen, Dave Youngs, Richard Thiessen, Ronald Koop,  
Betty Cordel

*Administrative Coordinator:* Deborah Osborne

#### Research Fellows

Arthur Wiebe, Judith Hillen, Richard Thiessen, Dave Youngs, Betty Cordel, Barbara Aston, Sheldon Erickson, Suzy Gazlay, Evelyn Hoover, Ronald Koop, David Mitchell, Myrna Mitchell, Ann Wiebe, Jim Wilson

#### Research Commission Coordinators

*Assessment:* Judith Hillen

*Publications:* Betty Cordel

#### Staff

*Webmaster/Internet Coordinator:* Johann Weber

#### Advisory Council

Care Butler, Thousand Oaks, CA; Cherie Cornick, Wayne County Alliance for Math and Science, Allen Park, MI; Linda Fawcett, Huron Intermediate School District, Port Austin, MI; Jeanne Just Janzen, Fresno Pacific University, Fresno, CA; Kay Kent, New Bern, NC; Evelyn Kovalick, Glendale, WV; Mary Lind, Monterey Peninsula Unified School District, Monterey, CA; Barbara Novelli, Pacific Grove Unified School District, Pacific Grove, CA; Brian Tash, Leucadia, CA;

#### Board of Directors

*President:* Richard Thiessen

*Vice President:* Ronald Koop

*Secretary:* Dave Youngs

*Treasurer:* Jon Hillen

*Member:* Arthur Wiebe

## In This Issue

We hope that this first issue of our seventeenth volume of *AIMS®* contributes to the excitement of your new school year. Knowing that many of you are spending the last few days of summer gearing up for the next nine months, we are trusting that this issue will arrive just in time to be incorporated into your long-range plans.

There is something for everyone. Do you want some ideas for Math? Take a look at the article *Knowing and Caring About Numbers*. In it Richard Thiessen addresses some number patterns that are "hidden" in the multiplication table. Students will be intrigued by the geometric designs they can make by connecting the digits in the patterns. More Math ideas can be found in *Primarily Problem Solving*, *Maximizing Math*, and *One Number Indivisible*.

What about ideas for Science? We have included Earth Science, Life Science, and Physical Science ideas. These run the gamut of the grade levels from primary through middle school.

We'd be pleased to serve you in any way possible—publications, products, staff-development workshops. You can contact us through the mail, by phone or fax, and through email. All the necessary information is in the left column.

As always, we appreciate your comments, suggestions, and activity ideas. Have a great year!



The AIMS magazine is being printed on recycled paper as a conservation effort.

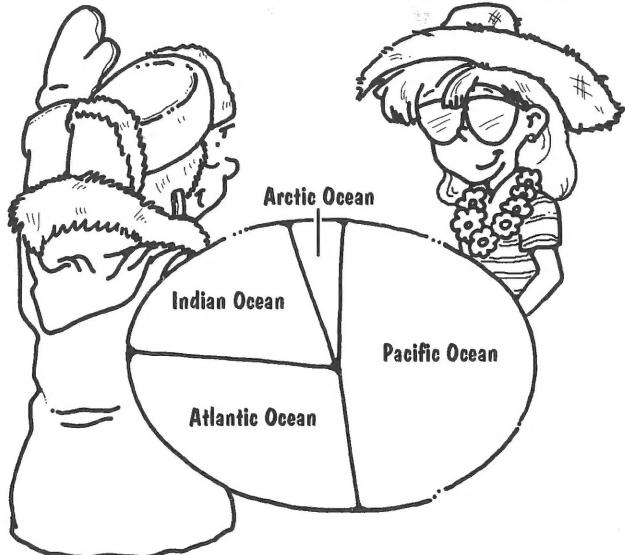
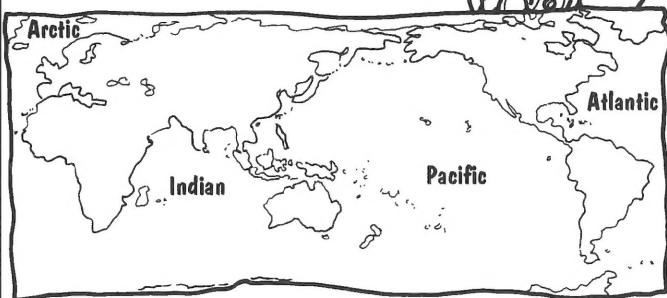
Copyright © 2002 by the AIMS Education Foundation

All rights reserved. No part of this work may be reproduced or transmitted in any form or by any means—graphic, electronic, or mechanical, including photocopying, taping, or information storage/retrieval systems—without written permission of the publisher unless such copying is expressly permitted by federal copyright law. The following is an exception to the foregoing statements:

- A person or school purchasing this AIMS publication is hereby granted permission to make up to 200 copies of any portion of it, provided these copies will be used for educational purposes.

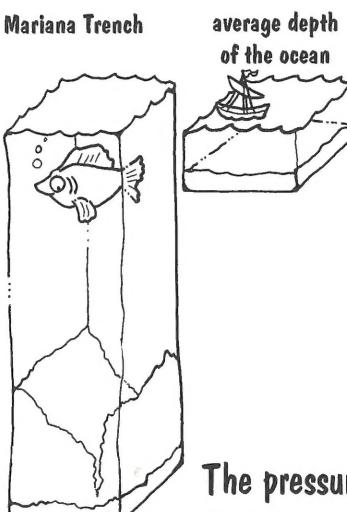
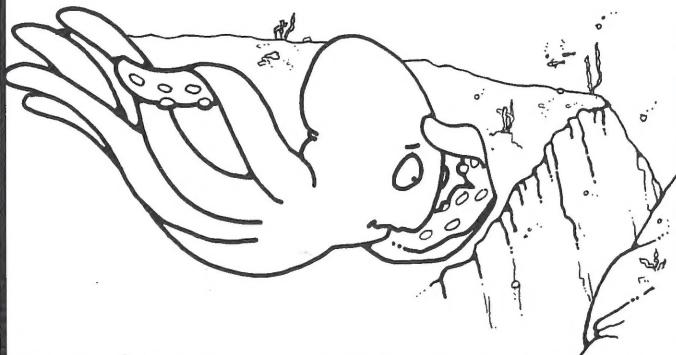
# Isn't It Interesting... Notions of Oceans

There are four major oceans on the Earth: Pacific, Atlantic, Indian, and Arctic. All are really one large body of water that covers nearly two-thirds of the Earth.

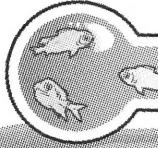


The Pacific Ocean is approximately 13 times larger in surface area than the Arctic Ocean. The Pacific Ocean covers about one-third of the surface of our planet.

The Mariana Trench, located on the floor of the western Pacific Ocean, has a depression that is thought to be the deepest point on Earth. The point, called the "Challenger Deep," is nearly seven miles deep.



The pressure at the bottom of the Mariana Trench measures about 8 tons per square inch. Average atmospheric pressure at sea level is 14.7 pounds per square inch. Big difference!!



# Temperature Layers of the Ocean

by David Mitchell

**Topic**  
Temperature Layers of the Ocean

**Key Questions**

Does the ocean have a layered structure like the atmosphere and solid Earth do?  
How can a graphic organizer help us better understand structures of the Earth?

**Learning Goals**

Students will:

1. collaboratively construct a model of the layers and temperature ranges in the ocean,
2. construct a circle graph of the layers of the ocean, and
3. compare and contrast the two models.

**Guiding Documents**

*Project 2061 Benchmarks*

- In something that consists of many parts, the parts usually influence one another.
- Thinking about things as systems means looking for how every part relates to others.

*NRC Standard*

- Earth materials are solid rocks, soils, liquid water, and the gases of the atmosphere. These varied materials have different physical and chemical properties.

*NCTM Standards 2000\**

- Design investigations to address a question and consider how data-collection methods affect the nature of the data set
- Represent data using tables and graphs such as line plots, bar graphs, and line graphs

**Math**

Data analysis

**Science**

Earth science  
oceanography

**Integrated Processes**

Observing  
Interpreting data  
Applying

Generalizing  
Comparing and contrasting

**Materials**

For each group of four students:

ocean layer graphic organizer sheet  
ocean circle graphic organizer sheet  
crayons: blue, green, and purple  
calculator  
protractor  
ruler

**Background Information**

Temperature Model of the Ocean's Structure

Oceanographers generally recognize a three-layer model for the open ocean. This model applies for the portions of the ocean between 40 degrees north latitude to 40 degrees south latitude. In the higher polar latitudes, surface waters are cold and temperature changes due to depth are slight.

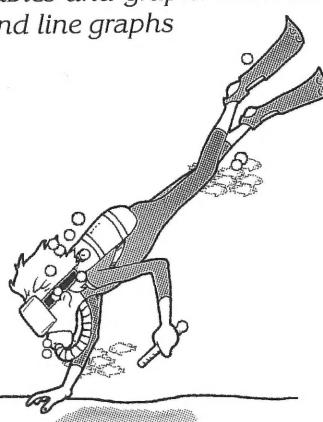
The sun is the major heating mechanism for the ocean. Motions of the ocean in the form of waves and currents mix the waters near the surface and transfer the heat downward. This zone of the ocean is called the *surface mixed zone*. The thickness of this zone varies from 100 meters to 400 meters. Its average depth is about 300 meters. The temperature of the water in this zone remains fairly constant and does not vary much with depth. It does vary by location from about 15 degrees Celsius near regions 40 degrees north and south of the Equator to 26 degrees Celsius near equatorial regions.

The second of the layers is the *thermocline*. This is the layer that has a rapid temperature drop. Near the top of the thermocline, the average temperature is about 21 degrees to about 5 degrees near the bottom of this zone at 800 meters.

The last zone is referred to as the *deep zone*. It ranges in depth from 800 meters to depths of 4000 meters and more. The water temperature of this zone averages a fairly constant 4 degrees Celsius.

**Management**

1. Divide your students into collaborative teams of four.
2. Prepare and read through each clue card.
3. Make sure the students understand that this model is based on the idea of average zones and depths.



There are deep trenches extending down more than 11,000 meters. This model will extend down to a depth of 4000 meters.

4. When discussing the two different graphic organizers, be sure to discuss the advantages and limitations of each type. [The first graphic organizer will help the students see relative sizes of each of the layers as well as the temperature range for each. The second graphic organizer will show each layer as a part of the whole, helping the students to see that most of the ocean is classified as the deep zone.]

#### Procedure

1. Ask the *Key Questions* and state the *Learning Goals*.
2. Tell the students that they will be divided into collaborative teams of four. Each student will get one clue card.
3. Direct the students to read the information on the card to the members of their group so the group can correctly construct the first graphic model of the ocean's temperature. The student holding the card can only read his or her card. Emphasize that students are not allowed to read each other's clues.
4. Distribute the student page that the students will use in constructing the first graphic organizer. Point out that they should work in pencil so that they can make changes if necessary.
5. Direct the students to construct a circle graph of the ocean layers.
6. Calculate the percentage of each layer and construct a circle graph to compare and contrast the two different graphic models of the temperature layers. (Use 4000 meters as the whole. Point out that this is used as an average depth amount.)
7. After each group is finished, compare the graphic models to check for accuracy.

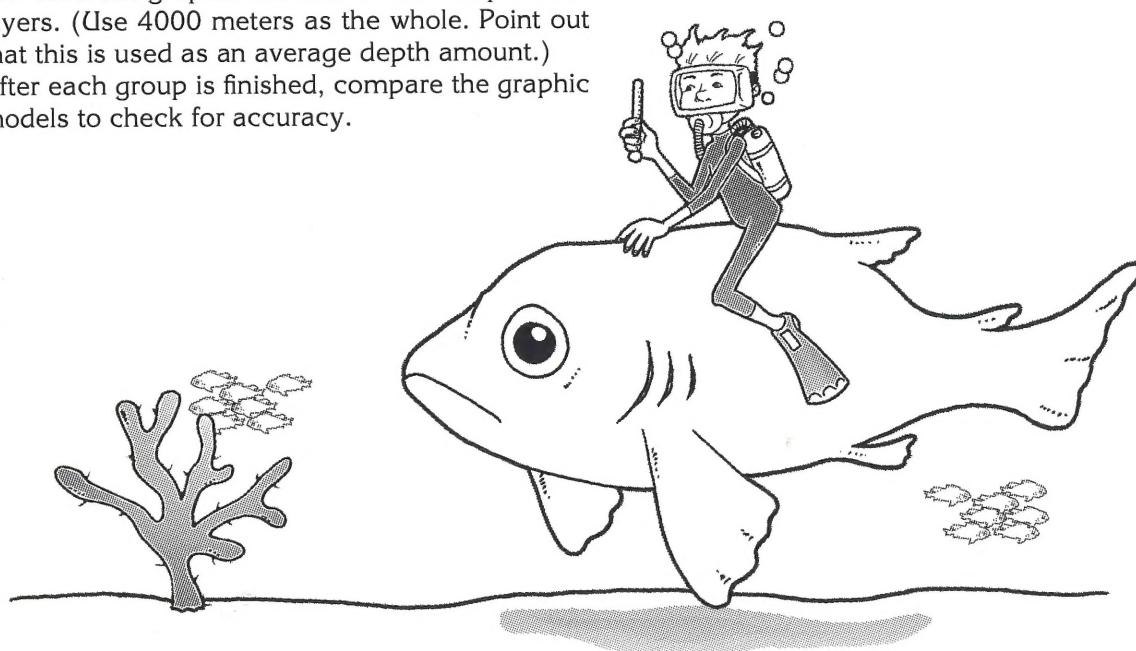
#### Reflecting on Learning

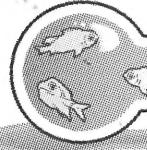
1. What are the three temperature layers of the ocean?
2. Why do you think scientists divide the ocean into layers? [Scientists try to classify objects and events into categories. Scientists classify the ocean based on temperature, ocean life as well as salinity.]
3. Why do you think the temperatures in the surface zone and deep zone are fairly constant?
4. What are the advantages of using different graphic organizers to show the same information? What are the disadvantages?
5. If you could only have one graphic organizer to show the temperature zones of the ocean, which one would you choose? Why would you choose this one?
6. What conclusions can you make about the depth of the ocean as it relates to temperature?

#### Evidence of Learning

1. Check the two graphic organizers for accuracy in the placement of the layers as well as the correct temperature ranges. The surface layer is the thinnest layer followed closely by the thermocline. The graphic organizers should both clearly show that the deep zone is the largest layer.
2. Check the student written responses as they compare and contrast the two graphic organizers. Look for reasoning based on the two graphic organizers they constructed.

\* Reprinted with permission from *Principles and Standards for School Mathematics*, 2000 by the National Council of Teachers of Mathematics. All rights reserved



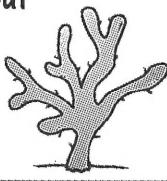


# Temperature Layers of the Ocean

## Oceanographer's Clue Card

**1**

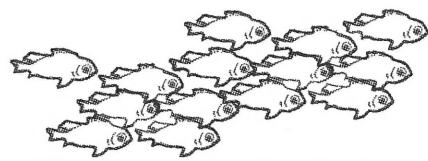
1. Oceanographers divide the ocean into three layers.
2. The temperature at 700 meters is about 7 degrees Celsius.
3. The layer below the thermocline is the thickest layer. Color it purple.
4. The temperature at 600 meters is about 9 degrees Celsius.
5. The top of the deep zone is about 800 meters.



## Oceanographer's Clue Card

**2**

1. The temperature at 1100 meters is about 4 degrees Celsius.
2. The thermocline is the middle layer. Color it blue.
3. The temperature at 100 meters is about 22 degrees Celsius.
4. Draw a line of best fit for the temperatures.



## Oceanographer's Clue Card

**3**

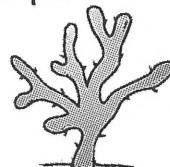
1. The temperature at 500 meters is about 11 degrees Celsius.
2. Draw a line between each layer and color each after you have drawn the line of best fit.
3. The temperature at the top of the deep zone is about 5 degrees Celsius.
4. The temperature at 400 meters is about 18 degrees Celsius.

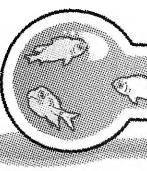


## Oceanographer's Clue Card

**4**

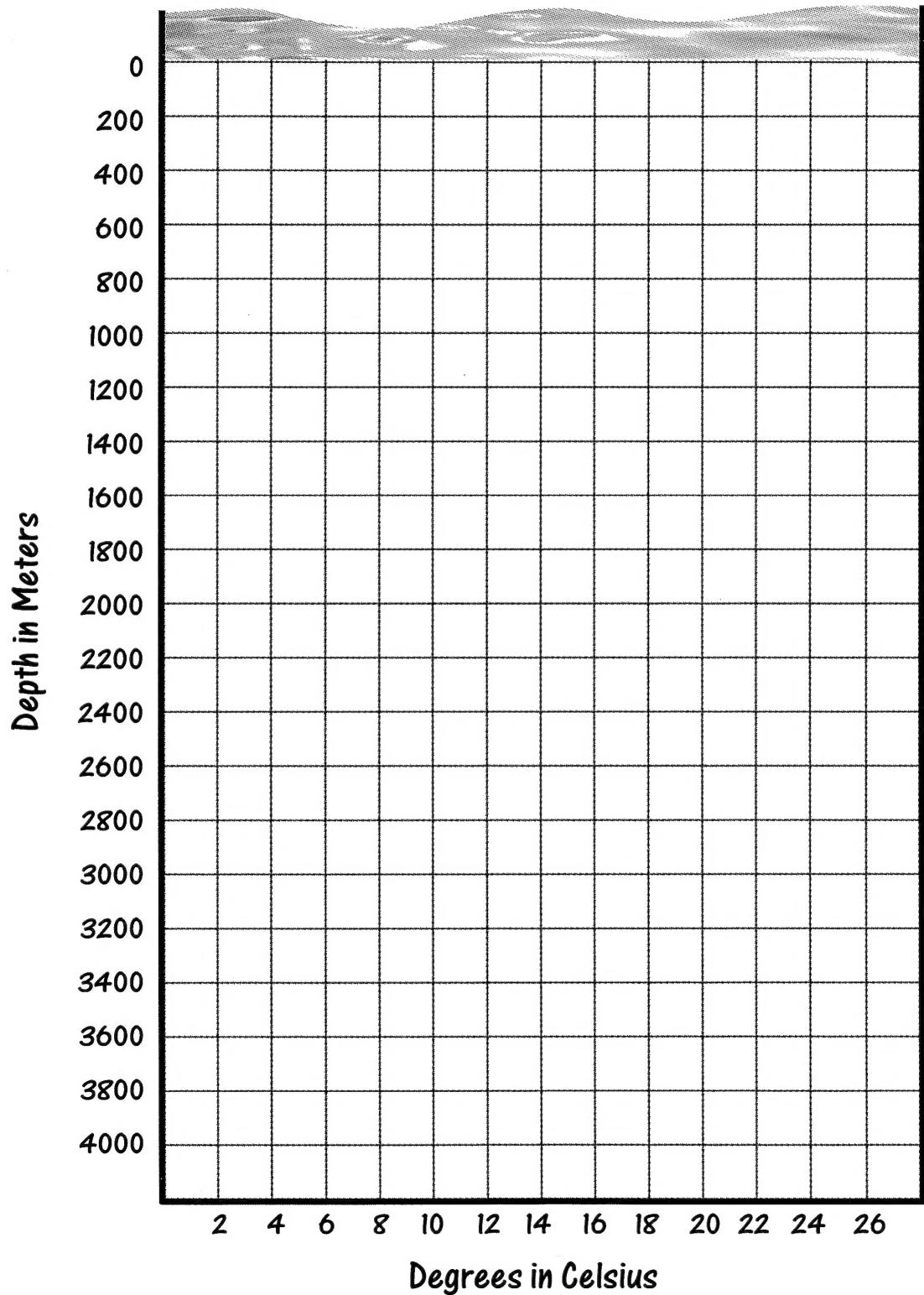
1. The temperature at 300 meters is about 22 degrees Celsius.
2. The temperature at 1300 meters is about 4 degrees Celsius and stays constant at that temperature to the bottom of the deep zone.
3. The surface zone extends down from the ocean's surface to an average depth of 300 meters.
4. Label the layers.

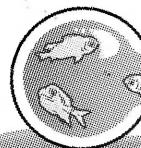




# Temperature Layers of the Ocean

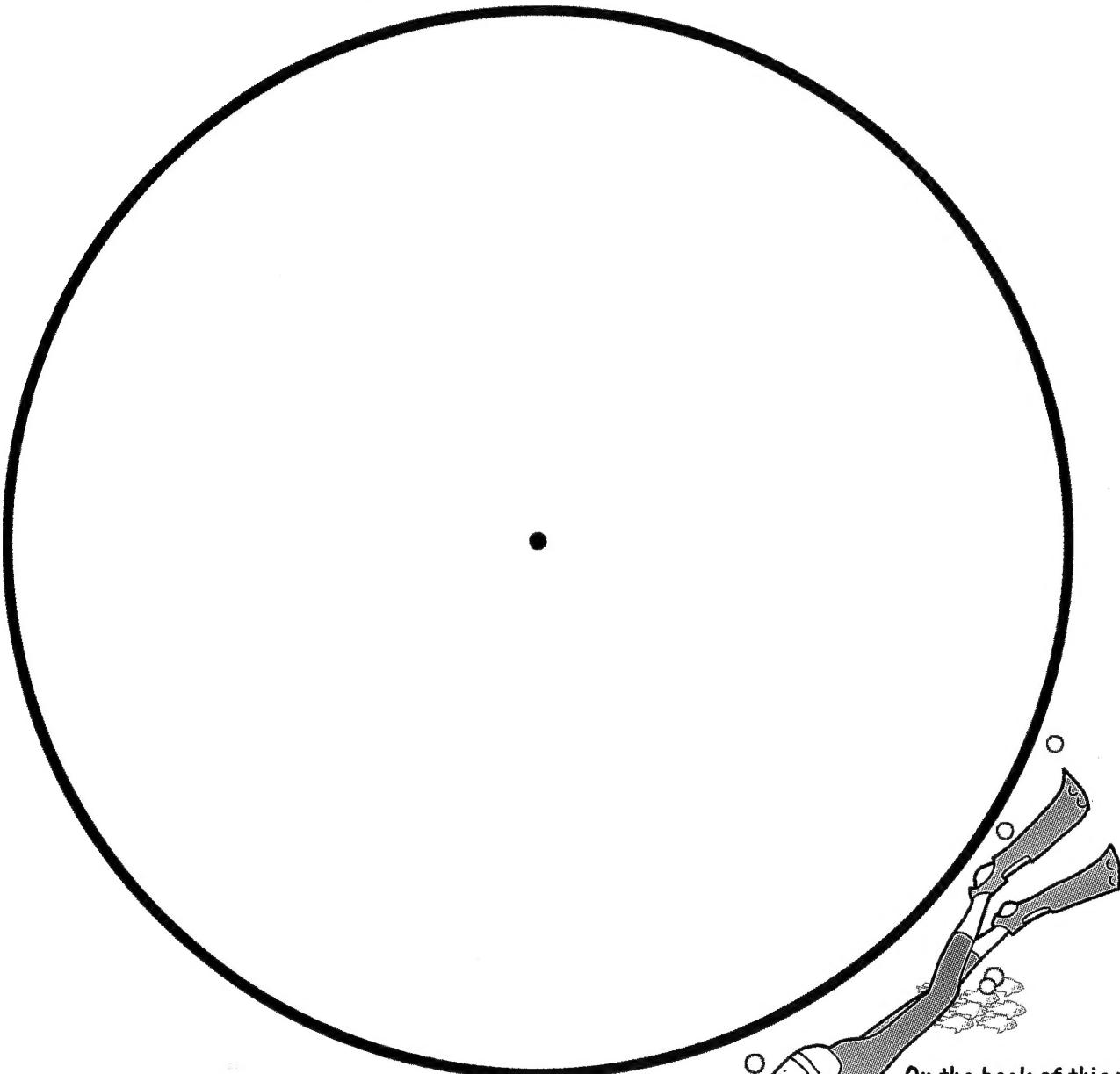
## Graphic Organizer #1 for Ocean Temperature



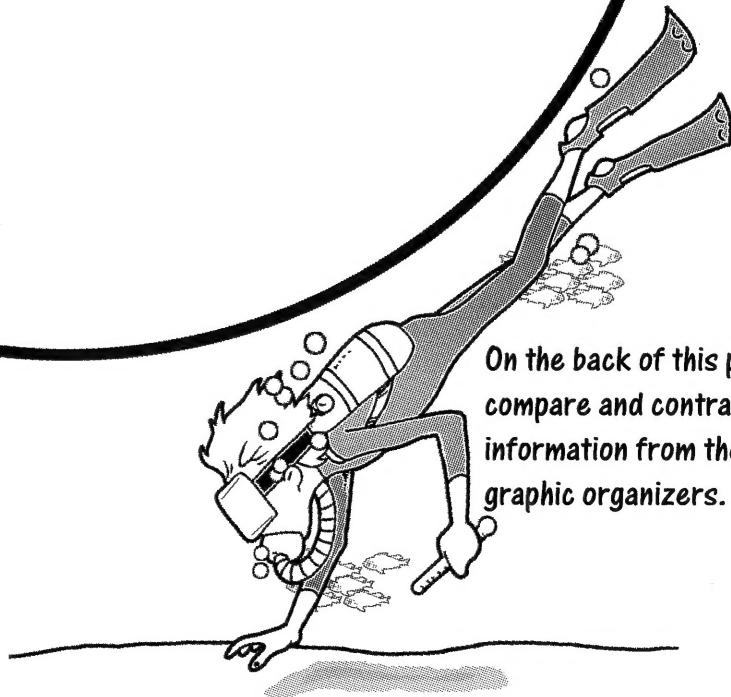


## Temperature Layers of the Ocean

### Graphic Organizer #2 for Ocean Temperature



**Key**



On the back of this paper,  
compare and contrast the  
information from the two  
graphic organizers.

# PRIMARILY PROBLEM SOLVING

## WHAT'S MY RULE?

by Michelle Pauls

This month's *Primarily Problem Solving* focuses on the first two algebra standards from the *NCTM Standards 2000*\*. These standards say that students in grades Pre-K–2 will:

- sort, classify, and order objects by size, number, and other properties
- recognize, describe, and extend patterns such as sequences of sounds and shapes or simple numeric patterns and translate from one representation to another

This activity is very open-ended and must be entirely teacher-directed. The manipulatives are provided, and examples of things to do are given, but the direction and structure the activity takes will be up to you as the teacher.

There are 16 shapes provided as manipulatives—four each of triangles, quadrilaterals, pentagons, and hexagons. Both regular and irregular shapes

have been included. Each shape has been labeled with a color—red, yellow, green, or blue. There is one of each shape in each color. These shapes should be copied onto card stock, colored (if possible), and cut out for students. If desired, you may laminate for durability. You may wish to make a set for yourself on an overhead transparency so that you can give examples for the whole class. Depending on the ages and abilities of your students, you may wish to use fewer than the 16 shapes provided.

These manipulatives can be used in a variety of ways. They can be placed at a center with task cards for students to explore, they can be distributed to groups and used in a whole-class setting, or they can be given to each student and used for different problems throughout the year. The intent is for them to be used to address the algebra standards given at the

beginning of this article. Following are some specific suggestions for ways in which to use the shapes. This list is by no means exhaustive.

### Patterning

Have students create or extend pre-created patterns based on color. The simplest of these might be a two-color pattern such as red, yellow, red, yellow.... More complex color patterns could use three or four colors (e.g. blue, green, yellow, red, blue... or yellow, green, yellow, blue, yellow, red, yellow....).

Other patterns could be based on size, number of sides/corners, or any combination of these features. For each pattern they create or extend, students should always be able to clearly state the rule used.

Ideas for using patterns in your class:

- Glue the shapes to a sentence strip or clip them from a string hung across the chalkboard. Students can use their shapes to duplicate and extend the pattern at their desks.
- Create task cards with a variety of sample patterns drawn on them. Provide spaces in which students can extend the pattern and record the rule. Place these cards at a center.
- Have students create patterns at their desks and trade them with classmates to see if the patterns can be extended and the rules discovered.
- Have students record patterns they create along with a statement defining the rule used for that pattern.

## **Sorting**

Have students sort the shapes using a variety of rules. Shapes could be sorted by color, by number of sides/corners, by size, by angle, etc. Shapes can be sorted into two or more categories. For each sort that students perform, they should always be able to clearly state the rule used.

Ideas for presenting sorting to your class:

- Perform various sorts on the overhead. Challenge students to determine the rule and place the remainder of the pieces where they belong.
- Create a sorting mat for students and have them use it to do their own sorts.
- Challenge students to find a rule to sort the shapes into

- two groups, three groups, four groups, and five groups.
- Have students sort into a Venn diagram where some categories overlap.
- Have students record the sorts they make along with a statement defining the rule used for that sort.

## **Ordering**

Have students order the shapes in as many ways as they can. Shapes could be ordered from fewest to most sides, smallest to largest, and so on. For each ordering that students create, they should always be able to clearly state the rule used.

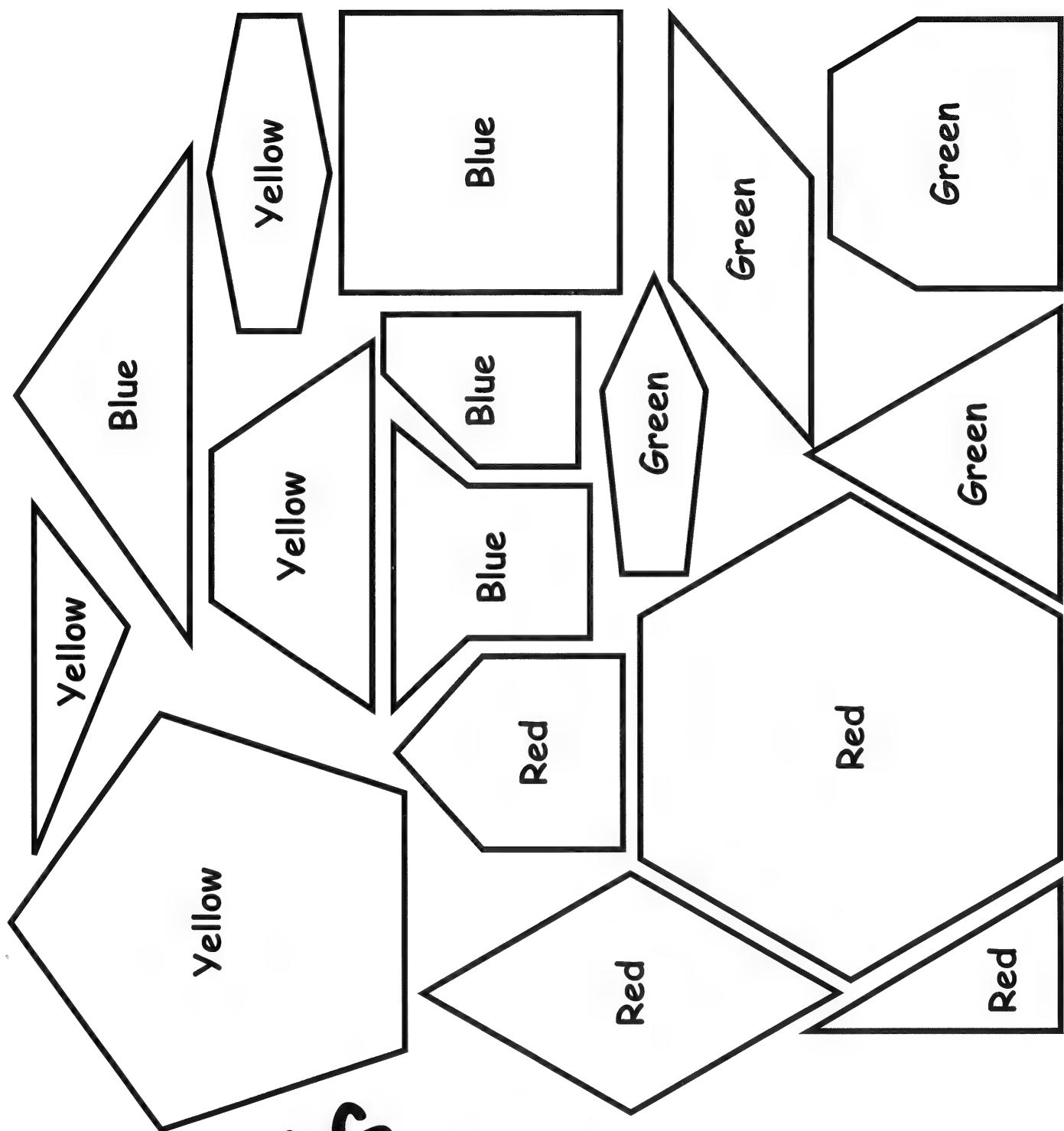
Ideas for presenting ordering to you class:

- Glue the shapes to a sentence strip or clip them from a string hung across the chalkboard. Students can use their shapes to duplicate and extend the order at their desks.
- Create task cards with a variety of sample orderings drawn on them. Provide spaces in which students can extend the order and record the rule. Place these cards at a center.
- Have students create orderings at their desks and trade them with classmates to see if the orders can be extended and the rules discovered.
- Have students record orders along with a statement defining the rule used.

As you can see, there are virtually infinite possibilities for

ways in which these shapes can be used to meet the first two NCTM algebra standards. To extend their use, explore the geometry standards using these shapes. I hope you and your students benefit from this open-ended activity. If you have any questions or feedback, please don't hesitate to contact me at AIMS.

\* Reprinted with permission from *Principles and Standards for School Mathematics*, 2000 by the National Council of Teachers of Mathematics. All rights reserved.



What's  
My  
Rule?

# Glyph Hangars

by Myrna Mitchell

## Topic

Data Analysis

## Key Question

What do the glyphs tell us about the students in our class?

## Focus

Students will gain information about the class through sorting and classifying student glyphs.

## Guiding Document

NCTM Standards 2000\*

- Sort and classify objects according to their attributes and organize data about the objects
- Represent data using concrete objects, pictures, and graphs
- Describe parts of the data and the set of data as a whole to determine what the data show
- Count with understanding and recognize "how many" in sets of objects

## Math

### Graphing

bar graph, circle graph

Venn diagram

## Integrated Processes

Observing

Comparing and contrasting

Classifying

Collecting and organizing data

Interpreting data

Drawing conclusions

Communicating

## Materials

Student pages

Crayons

Scissors

Yarn (see Management 7)

Glue

## Background Information

Ancient Egyptians and Native Americans were both noted for their unique picture writing. Through the use of hieroglyphics and pictographs, information was communicated using pictorial symbols that represented meaning or sounds.

In this activity students will create glyphs. The word *glyph* is taken from the word *hieroglyphics*. Glyphs are pictures or symbols that communicate information without words. A handicap accessible symbol in a restroom and a non-smoking sign in a restaurant are examples of information in pictorial display.

In this activity, the details of the finished glyphs give information about the students who have created them. A legend will allow students to interpret what each part of the glyph means. The students will use the glyphs to collect, sort, display, and interpret data about their classmates. Using glyphs makes data collection and analysis fun for your students while also allowing them to practice using a legend in the creation of the glyph.

## Management

- Have several examples of picture writing available for your students to examine. Include such things as Egyptian hieroglyphics, Native American picture writing, and present day symbols such as the handicap accessible symbol, available for your students to examine. (See *Curriculum Correlation*.)
- Display the legend where it can easily seen by all students. This can be done by enlarging it onto chart paper or by making an overhead transparency of it.
- The data collection process will be determined by the ability of the students. For younger students, you will want to present the survey/legend one step at a time. With older students, all the material can be presented in one step, with the survey/legend on one sheet of paper that each student receives. As you go through the glyph, emphasize the meaning of the features. This will help the students to focus on what they mean and not what they are.
- Prior to teaching this lesson, complete a glyph that represents your responses to the legend questions.
- It is assumed that the students have had prior experience with bar graphs, circle graphs, and Venn diagrams.
- This activity should to be spread out over several days.
- Several three-meter lengths of yarn in two colors will be used for *Part Two* of this activity.

## **Procedure**

### *Part One—Making the Glyph*

1. Lead your students in a discussion about picture writing and hieroglyphics. Show the students several examples and have them infer what each picture represents. Tell your students that they will be doing some picture writing to communicate information about themselves.
2. Show the students your completed glyph. Ask them what they notice about the book bag. [There is a red apple in it, there is a glue stick in it, etc.] Tell the students that the pictures represent things about you.
3. Draw the students' attention to the legend. Show them how the glue stick in the book bag means that this book bag belongs to a girl or how the white glue in the book bag means the bag belongs to a boy. Continue using the legend to interpret your sample book bag. To reinforce writing, you may ask the students to help you write sentences that describe you, based on your picture. For example, I am a girl that walks to school. I bring my lunch to school, etc.
4. Distribute a set of student pages to each student.
5. Ask students to think about how they get to school most mornings. Explain that the legend will tell them what color to color their apple based on how they get to school.
6. Ask all students who walk to school most mornings to raise their hands. Refer the students to the first section of their survey page where the word yellow is written below the picture of the student walking. Tell those students to take their yellow crayon and circle the picture of the student walking to remind them later to color their apple yellow.
7. Ask the students what color they should color their apple if they ride to school in a car most mornings. [red] Tell those students to make a red mark with their crayon around the picture of a car to remind them later to color their apple red. Follow the same procedure for those students who ride a bus to school most mornings. Allow the class time to color their apples and cut them out before moving on.
8. Draw the students' attention back to the survey page. Read question two aloud. Have the students circle their response. Allow them time to go to the page of pictures and cut out the glue container that matches their response. Wait as they glue the picture on the book bag.
9. Ask the students to look at question three on the student survey page. Explain that they are to write their age on the box of crayons that is drawn on the book bag. Tell them to circle the five if they are five, six if they are six, etc. Give them time to write the correct number on the crayon box that is on the book bag.
10. Read question four aloud. Ask the students to respond by circling either the open or closed scissors. Instruct them to cut the correct pair of scissors out from the picture page.

11. Allow time for the students to color and glue the pictures onto their book bag. Collect the book bag glyphs.

12. Display a glyph and ask the students to use the legend to help you describe the owner of the book bag. Repeat the process several times until the students are comfortable with using a legend to "read" the glyphs.

### *Part Two—Data collection, Organization and Analysis*

1. Gather the students around the collection of glyphs. Ask students to think about different ways the glyphs could be sorted.
2. Invite a student to sort the glyphs using a rule. [Girls/boys, walkers/bus riders/car riders, etc.] Ask the students if they can identify the rule.
3. On the floor, assist students in placing the glyphs so that they create a bar graph. Analyze the data by asking questions such as, Which do we have more of? ...less of? Why do you think we have more \_\_\_\_? Do you think that we would get the same results if we made glyphs in a different grade level, etc.
4. Return the glyphs to a sorting area. Encourage students to sort the glyphs using a new rule. Allow a student to demonstrate the sort.
5. Organize and display the glyphs in a circle graph. Separate the sections with pieces of yarn. Be sure to label the sections.
6. Discuss the results of the sort. Compare the circle graph display to the bar graph display.
7. Continue sorting, using a new rule.
8. Place two different colored yarn circles on the floor. Label one set *girls* and the other *bus riders*. Place the class glyphs in the correct sets. For those glyphs that represent girls that are bus riders, overlap the circles to create a set with both characteristics. Analyze the class data. Discuss commonalities among the students and other possible ways to sort and display the glyphs.

## **Discussion**

1. How many girls do we have in our class? ...boys?
2. How do you know what each picture means?
3. How are our glyphs like hieroglyphics?
4. Choose a glyph. Based on the glyph, what do you know about the student who created it?
5. Name several rules that we could use to sort the glyphs.

## **Curriculum Correlation**

### *Internet Connection*

Examples of hieroglyphics and pictographs:  
<http://www.seaworld.org/Egypt/hiero.html>

<http://www.sunysuffolk.edu/~votil90/Hieroglyphics.htm>

<http://net.indra.com/~dheyser/gallery1/gallery1.html>

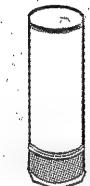
\* Reprinted with permission from *Principles and Standards for School Mathematics*, 2000 by the National Council of Teachers of Mathematics. All rights reserved.

# ===== Glyph Hangers =====

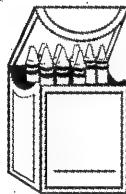
## Legend



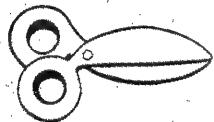
= Boy



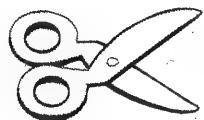
= Girl



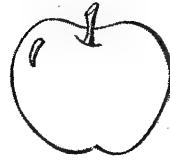
= Age



= Buy lunch



= Bring lunch



red = car

yellow = walk

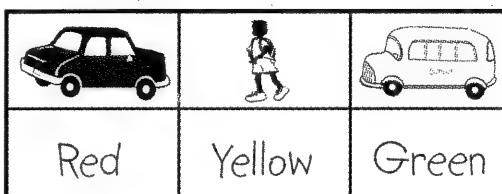
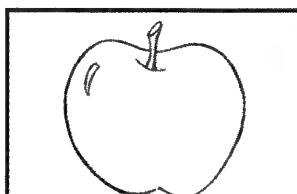
green = bus



# ===== Glyph Hangers =====

## Student Survey

1. How do you get to school?

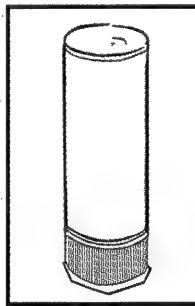


Color apple

2. Are you a boy or a girl?

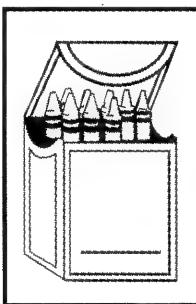


Boy



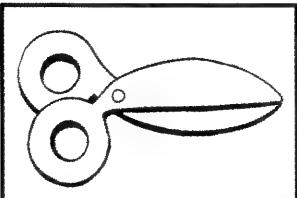
Girl

3. How old are you?

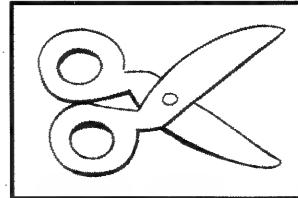


5	6	7	8
5 years old	6 years old	7 years old	8 years old

4. Do you bring or buy your lunch?

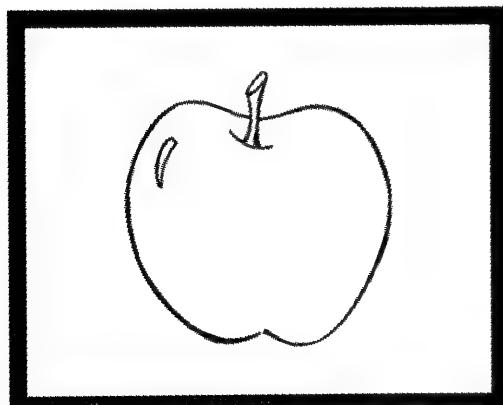
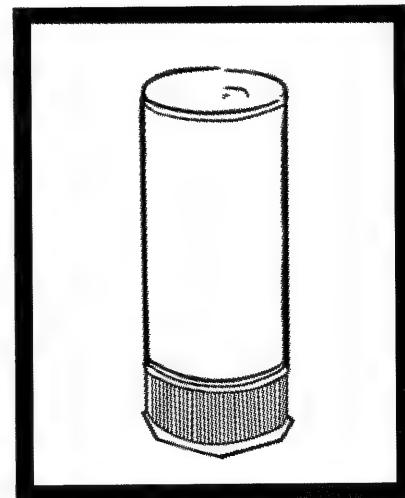
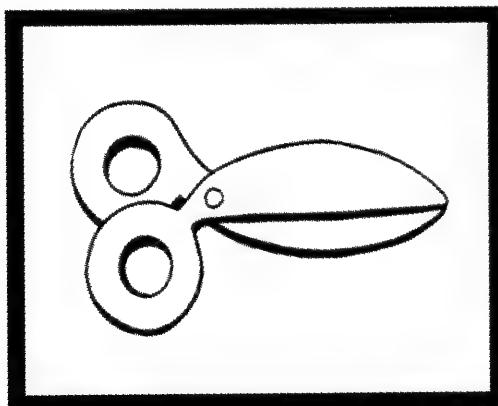
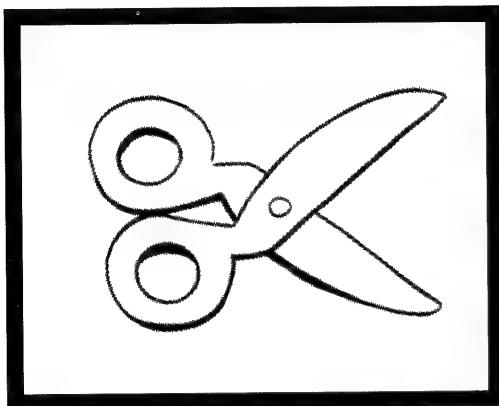


Buy



Bring

# Glyph Hangers



# ===== Glyph Hangers =====





# One Number IN★VISIBLE

by Judith Hillen

## Topic

Prime and composite numbers

## Learning Goals

Students will

- explore prime and composite numbers by constructing rectangles with square area tiles, and
- organize their findings and generalize that some numbers are divisible only by one and themselves (prime) and others have multiple divisors.

## Guiding Document

NCTM Standards 2000\*

- Understand numbers, ways of representing numbers, relationships among numbers and number systems*
- Describe classes of numbers (e.g., odds, primes, squares, and multiples) according to characteristics such as the nature of their factors*
- Recognize equivalent representations for the same number and generate them by decomposing and composing numbers*

## Materials

For each student:

12–15 square area tiles  
scissors  
2-cm grid paper  
index cards, 3" x 5"

## Math

Number sense  
prime/composite

## Integrated Processes

Observing  
Comparing and contrasting  
Generalizing

## Background Information

Whole numbers can be represented pictorially in two-dimensional form by constructing rectangular arrays with square area tiles. As students build the rectangular arrays, they will discover that some numbers can only be made using lengths of that number and one. These are the prime numbers. A prime number is any number greater than one that has only two divisors, one and itself. Composite numbers are numbers that

have more than two divisors. There will be more than one array for each composite number.

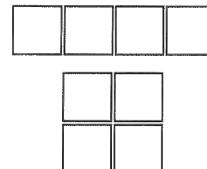
The opportunity for the development of mathematical language is a powerful piece of this experience. Such terms as factor, multiple, divisor, prime, composite, compose, decompose, prime factors, and prime factorization are integral to this lesson.

## Management

- Students should work in pairs or teams of four to collect and share data.
- You may wish to adjust the range of whole numbers that students search. For third and fourth graders, 2–12 is suggested. Perhaps for fifth and sixth graders, the search should be expanded to 20. This would include the most frequently used prime factors—2, 3, 5, 7, 11, 13, 17, and 19.

## Procedure

- Distribute tiles to students and explain that they are to build as many different rectangles as are possible for each whole number between 2 and 12.
- Demonstrate the rectangles possible for 4. Then explain that a line of 4 tiles and a square region of 4 tiles are the only two possible rectangles that can be constructed from four tiles.

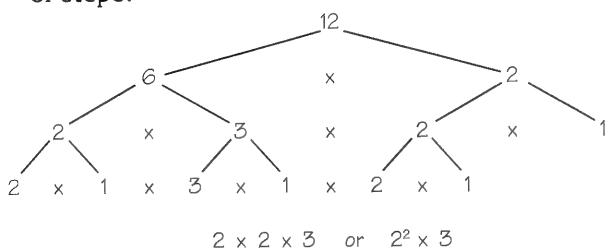


- As rectangles are completed, ask students to cut a matching rectangle from 2-cm square grid paper.
- Direct them to match paper rectangles with each number between 2 and 12 representing the total number of square units or tiles in each rectangle.
- Ask students to make an organized, symbolic/numeric record of each rectangle by drawing a picture of the array and recording the length and width of each array. Demonstrate that rectangles for 4 can be written  $1 \times 4$  and  $2 \times 2$ .
- Ask students to record observations and look for generalizations about the rectangles and the numbers they represent.

7. Help students confirm the idea that a prime number is any number greater than one with factors (divisors) of only one and itself. Ask them to verify the prime numbers between 2 and 12 for which they built rectangles. Each of these primes has only one rectangle possible. The remaining numbers have two or more possible rectangles with factors (divisors) other than one and itself and represent composite numbers.

### Discussion

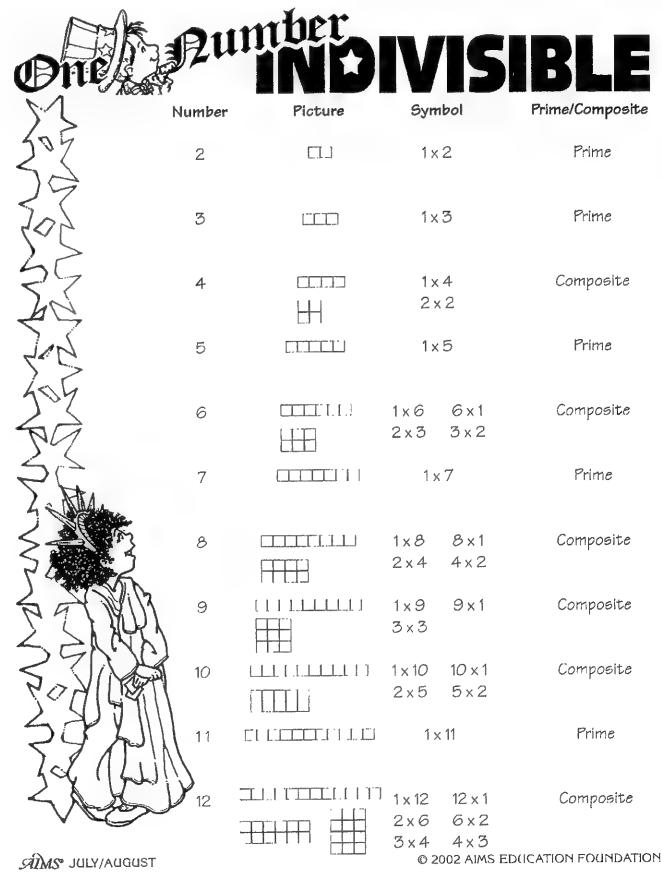
1. How are the rectangles that you constructed alike and/or different from each other? [All rectangles have four sides. Some are squares. Some are only one unit wide while others are two or more units wide.]
2. What role do the sides of the rectangle play? [They determine the factors or divisors.]
3. Use the cut paper rectangles to compare the picture of each rectangle to its symbolic record. How are the factors related to the rectangular array? [The factors or divisors represent the two dimensions of the rectangle.]
4. When you match all of the rectangles to the numbers between 2 and 12, what observations can be made about the relationships between the numbers and the pictures? [The fewer the number of rectangles, the fewer the number of factors or divisors of that number. Some numbers have only two divisors, 1 and itself. Others have several more divisors.]
5. Challenge students to examine the *100 Chart* and determine which numbers are prime between 1 and 100. Cross out numbers in the chart that are divisible by a factor other than 1 or itself. What are the only four divisors that need to be considered to eliminate all the composite numbers in that chart? [2, 3, 5, 7.] What is the common characteristic of these four numbers? [They are the first four prime numbers.]
6. Provide practice factoring numbers into their prime factors by doing *Factor—Ease*. (See activity page). Explain that a number can be decomposed or broken down into its prime factors through a series of steps.



Have students try other numbers such as 12, 42, 39, etc. Distribute index cards and assign a number to be factored to each card. Compare and organize the cards. Look for patterns. Make a generalization about the factors of all the numbers less than 100.

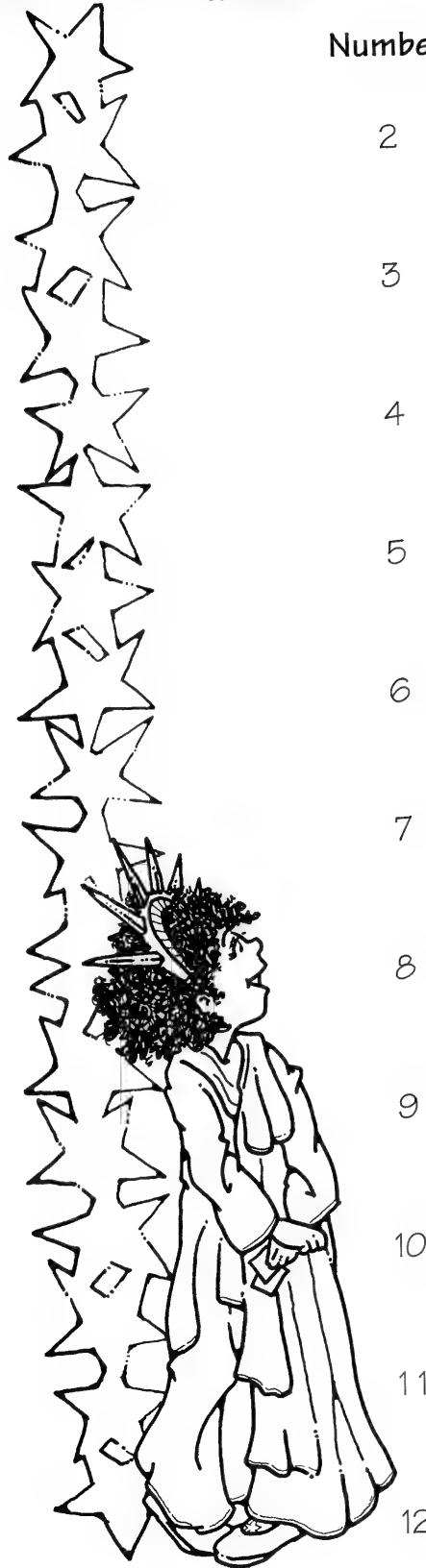
## Extensions

1. Have students play around with the idea that any even number greater than 2 can be expressed as the sum of two prime numbers. This is known as Goldbach's Conjecture and has never been proven or disproven. Goldbach lived in the early 16<sup>th</sup> century so lots of time has passed for young mathematicians to work on this problem! Make a list of all the primes between 1 and 100. What patterns or "conjectures" can you invent based on relationships you observed?
2. Challenge students to explore the sums of the divisors of any number in search of the "perfect" number. A perfect number is a number whose divisors smaller than itself add up to the number itself. For example, 6 is a perfect number because all its divisors smaller than six, 1, 2, 3, add up to 6. Six is the first perfect number. Can students find the next perfect number? (Hint: It is less than 100.) This idea is cleverly presented in *Math For Smarty Pants* by Marilyn Burns published by Little, Brown & Co., 1982. ISBN 0-316-11739-0. The article is called, "Some Numbers are More Perfect Than Others," p. 124 – 126.



\* Reprinted with permission from *Principles and Standards for School Mathematics*, 2000 by the National Council of Teachers of Mathematics. All rights reserved.

# One Number INDIVISIBLE



Number      Picture      Symbol      Prime/Composite

2



$1 \times 2$

prime

3

4

5

6

7

8

9

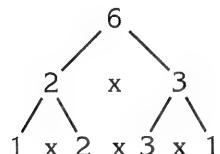
10

11

12

# One Number INDIVISIBLE Factor-Ease

Select eight composite numbers from the Hundreds Chart and picture their separation into factors until all factors are prime. Use the back of the paper if necessary.



Why do you think some numbers have only two levels of separation and others have more?

How could you use exponents to abbreviate or consolidate your notation?





# Number **INDIVISIBLE** SPECIAL FOUR

100 Chart

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Cross out all numbers that are not prime.



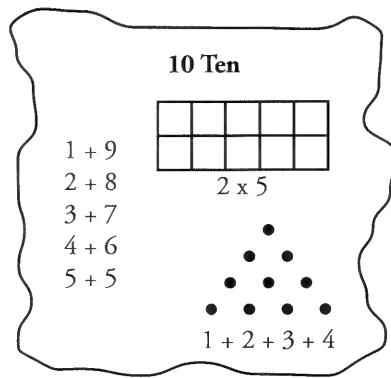
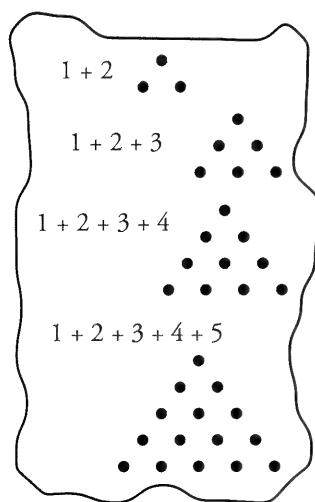
A blank 8x8 grid of squares, suitable for various games like Sudoku or crosswords.

# **Knowing & Caring About Numbers: The Multiplication Table**

**by Richard Thiessen**

This is the fourth in a series of articles that began with an idea about creating a number wall something like the more familiar word walls that can be found in many classrooms. Depending on grade level, the wall might, for example, have individual numbers written on sheets of paper and then along with the numbers have some of the things that students know about those numbers. The numbers might be identified as odd or even; there might be a listing of all addition facts that sum to that number; if the number were nine, it might be noted that it is a square number and that it is the sum of the first three odd numbers. In a third grade class with the numbers one through 18 exhibited in this way, students might notice that four is a square number and can be expressed as the sum of the first two odd numbers. Then they might notice that 16 is a square number and it is the sum of the first four odd numbers. These observations might then lead to a discussion about square numbers and numbers that can be expressed as the sum of consecutive odd numbers. Imagine your students generating and investigating such a question as, Is the sum of consecutive odd numbers beginning with one always a square number? This could lead to the creation of a listing of sums of consecutive odd numbers beginning with one that would show that it is indeed true that the sum is always a square number. Moreover, this listing might be placed on a larger sheet of paper that too could be exhibited on the number wall. While exhibits on the number wall might change from time to time, keeping them there for a period of time provides a

reminder of something important that was discovered by the class. If these exhibits are labeled or titled, they also can serve to keep the language of numbers and number ideas in front of students.



This article will explore some of the patterns that are found in the multiplication table. It is my hope that you will not only find this an interesting exploration yourself, but that you will find ideas that you can share with your students as well. Results of this exploration will make great additions to a number wall.

While a table of multiplication facts generally looks something like the one we have exhibited here, I want us to focus on only the units digit of each product in the table. To make that easier to do, let's create a new table in which only the units digit of each product appears. The new table is simply the old one from which we have erased the digit appearing in the tens place. Focusing on just the units digit of a sequence of numbers can reveal patterns that may be missed when looking at the entire numeral.

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

1	2	3	4	5	6	7	8	9
2	4	6	8	0	2	4	6	8
3	6	9	2	5	8	1	4	7
4	8	2	6	0	4	8	2	6
5	0	5	0	5	0	5	0	5
6	2	8	4	0	6	2	8	4
7	4	1	8	5	2	9	6	
8	6	4	2	0	8	6	4	2
9	8	7	6	5	4	3	2	1

Let's play around with that idea just a bit, and then we'll come back to the multiplication table. Consider the list of numbers from one through 40. What pattern do you see if the digits in the tens place are erased? Clearly we see the sequence of ten digits 1, 2, 3, 4, 5, 6, 7, 8, 9, 0 repeated four times.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40  
1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0

Suppose you made a list of just the even numbers to 40, what is the pattern of units digits, or how about the odd numbers to 40? For the even numbers we see the sequence 2, 4, 6, 0 repeated, and for the odd numbers we see the sequence 1, 3, 5, 7, 9 repeated. These are the units digit patterns with which students are most familiar because it is a way to identify whether a number is even or odd. The other pattern of units digits familiar to students is the 0, 5, 0, 5, 0, 5 pattern of multiples of five. Let's look at the patterns of multiples for each of the numbers from one through nine by simply listing the first 19 of each. Again, we are simply looking at what happens in the units digit of these multiples.

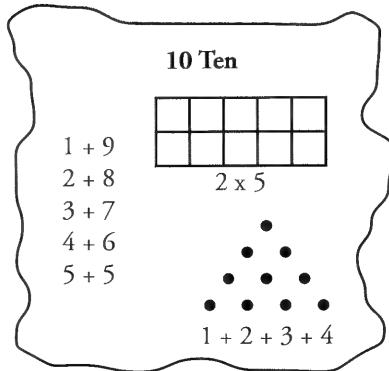
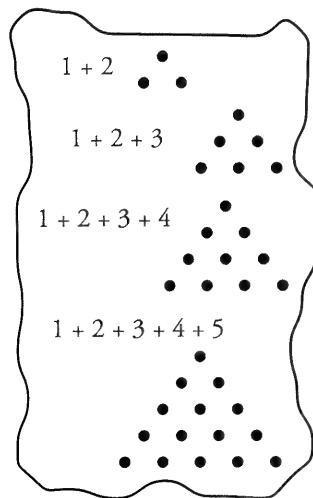
What are the patterns in these lists of the units digits of the various multiples? Do you see that the multiples of nine repeat the same sequence of digits,

1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9  
2, 4, 6, 8, 0, 2, 4, 6, 8, 0, 2, 4, 6, 8, 0, 2, 4, 6, 8  
3, 6, 9, 2, 5, 8, 1, 4, 7, 0, 3, 6, 9, 2, 5, 8, 1, 4, 7  
4, 8, 2, 6, 0, 4, 8, 2, 6, 0, 4, 8, 2, 6, 0, 4, 8, 2, 6  
5, 0, 5, 0, 5, 0, 5, 0, 5, 0, 5, 0, 5, 0, 5, 0, 5, 0, 5  
6, 2, 8, 4, 0, 6, 2, 8, 4, 0, 6, 2, 8, 4, 0, 6, 2, 8, 4  
7, 4, 1, 8, 5, 2, 9, 6, 3, 0, 7, 4, 1, 8, 5, 2, 9, 6, 3  
8, 6, 4, 2, 0, 8, 6, 4, 2, 0, 8, 6, 4, 2, 0, 8, 6, 4, 2  
9, 8, 7, 6, 5, 4, 3, 2, 1, 0, 9, 8, 7, 6, 5, 4, 3, 2, 1

# **Knowing & Caring About Numbers: The Multiplication Table**

**by Richard Thiessen**

This is the fourth in a series of articles that began with an idea about creating a number wall something like the more familiar word walls that can be found in many classrooms. Depending on grade level, the wall might, for example, have individual numbers written on sheets of paper and then along with the numbers have some of the things that students know about those numbers. The numbers might be identified as odd or even; there might be a listing of all addition facts that sum to that number; if the number were nine, it might be noted that it is a square number and that it is the sum of the first three odd numbers. In a third grade class with the numbers one through 18 exhibited in this way, students might notice that four is a square number and can be expressed as the sum of the first two odd numbers. Then they might notice that 16 is a square number and it is the sum of the first four odd numbers. These observations might then lead to a discussion about square numbers and numbers that can be expressed as the sum of consecutive odd numbers. Imagine your students generating and investigating such a question as, Is the sum of consecutive odd numbers beginning with one always a square number? This could lead to the creation of a listing of sums of consecutive odd numbers beginning with one that would show that it is indeed true that the sum is always a square number. Moreover, this listing might be placed on a larger sheet of paper that too could be exhibited on the number wall. While exhibits on the number wall might change from time to time, keeping them there for a period of time provides a reminder of something important that was discovered by the class. If these exhibits are labeled or titled, they also can serve to keep the language of numbers and number ideas in front of students.



This article will explore some of the patterns that are found in the multiplication table. It is my hope that you will not only find this an interesting exploration yourself, but that you will find ideas that you can share with your students as well. Results of this exploration will make great additions to a number wall.

While a table of multiplication facts generally looks something like the one we have exhibited here, I want us to focus on only the units digit of each product in the table. To make that easier to do, let's create a new table in which only the units digit of each product appears. The new table is simply the old one from which we have erased the digit appearing in the tens place. Focusing on just the units digit of a sequence of numbers can reveal patterns that may be missed when looking at the entire numeral.

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

1	2	3	4	5	6	7	8	9
2	4	6	8	0	2	4	6	8
3	6	9	2	5	8	1	4	7
4	8	2	6	0	4	8	2	6
5	0	5	0	5	0	5	0	5
6	2	8	4	0	6	2	8	4
7	4	1	8	5	2	9	6	
8	6	4	2	0	8	6	4	2
9	8	7	6	5	4	3	2	1

Let's play around with that idea just a bit, and then we'll come back to the multiplication table. Consider the list of numbers from one through 40. What pattern do you see if the digits in the tens place are erased? Clearly we see the sequence of ten digits 1, 2, 3, 4, 5, 6, 7, 8, 9, 0 repeated four times.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40  
1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0

Suppose you made a list of just the even numbers to 40, what is the pattern of units digits, or how about the odd numbers to 40? For the even numbers we see the sequence 2, 4, 6, 0 repeated, and for the odd numbers we see the sequence 1, 3, 5, 7, 9 repeated. These are the units digit patterns with which students are most familiar because it is a way to identify whether a number is even or odd. The other pattern of units digits familiar to students is the 0, 5, 0, 5, 0, 5 pattern of multiples of five. Let's look at the patterns of multiples for each of the numbers from one through nine by simply listing the first 19 of each. Again, we are simply looking at what happens in the units digit of these multiples.

What are the patterns in these lists of the units digits of the various multiples? Do you see that the multiples of nine repeat the same sequence of digits,

1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9  
2, 4, 6, 8, 0, 2, 4, 6, 8, 0, 2, 4, 6, 8, 0, 2, 4, 6, 8  
3, 6, 9, 2, 5, 8, 1, 4, 7, 0, 3, 6, 9, 2, 5, 8, 1, 4, 7  
4, 8, 2, 6, 0, 4, 8, 2, 6, 0, 4, 8, 2, 6, 0, 4, 8, 2, 6  
5, 0, 5, 0, 5, 0, 5, 0, 5, 0, 5, 0, 5, 0, 5, 0, 5, 0, 5  
6, 2, 8, 4, 0, 6, 2, 8, 4, 0, 6, 2, 8, 4, 0, 6, 2, 8, 4  
7, 4, 1, 8, 5, 2, 9, 6, 3, 0, 7, 4, 1, 8, 5, 2, 9, 6, 3  
8, 6, 4, 2, 0, 8, 6, 4, 2, 0, 8, 6, 4, 2, 0, 8, 6, 4, 2  
9, 8, 7, 6, 5, 4, 3, 2, 1, 0, 9, 8, 7, 6, 5, 4, 3, 2, 1

except they are reversed? But this is also true for the multiples of eight. They are the reverse of the multiples of two, and similarly for seven and three and six and four. The exception is the multiples of five, which stand alone, but which serve as a "sort of line of symmetry" for the pairs of multiples we have just noted.

There is another pattern that is worth noticing, but probably not so obvious. Look at the first multiple of one, the second multiple of two, the third multiple of three, the fourth multiple of four, and so on down the diagonal from upper left to lower right. These entries are the units digits of square numbers. This sequence might not be quite as familiar or obvious as the multiples, so let's list the numbers 1 through 19 and along side each number list the square of that number. Since we may not know and certainly students will not know the squares of all of these numbers, we will either need to do the multiplication by hand or use a calculator.

1 - 1, 2 - 4, 3 - 9, 4 - 16, 5 - 25, 6 - 36, 7 - 49, 8 - 64, 9 - 81, 10 - 100, 11 - 121, 12 - 144, 13 - 169, 14 - 196, 15 - 225, 16 - 256, 17 - 289, 18 - 324, 19 - 361

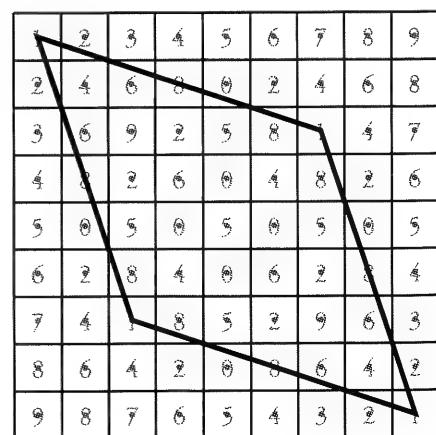
Now if we simply list the units digit of these squares, we have what seems to me an amazing pattern of units place digits that repeat over and over again. It's as though we took the symmetric pattern 1 4 9 6 5 6 9 4 1 and repeated it over and over again, marking the separation of these repeated patterns with zeros.

1 4 9 6 5 6 9 4 1 0 1 4 9 6 5 6 9 4 1

There are, of course, many other patterns like these that we might explore, but let's get back to the multiplication table with only the units digit showing. Actually if we cut off each row of our listing of units digits of multiples after the first nine entries, we have the multiplication table. So that the multiplication table exhibits exactly the patterns of multiples and squares that we have been exploring. In fact, there is one other thing that jumps out when you focus only on the table. Look at the diagonal entries from upper right to lower left. Do you see that this diagonal contains the same entries, but the entries have a different order? However, notice if you add the corresponding digits of the two diagonals, they always sum to ten. This is also true for the corresponding rows of multiples that we looked at earlier. For example, look at the multiples of seven and three, the sums of corresponding digits are  $3 + 7, 6 + 4$ , and so on. In each case the sum is ten.

While I'm fascinated by the number patterns we have just observed, I'm even more fascinated by the visual, geometric patterns that appear in this unusual multiplication table. If we place a dot in the center of each entry of the table, we can connect certain dots and look at the resulting shapes. For example, suppose we look at each square within the table that contains the digit one. If we connect the dots at the centers of these squares, a parallelogram is formed that is symmetric about the two diagonals of the table. Now let's

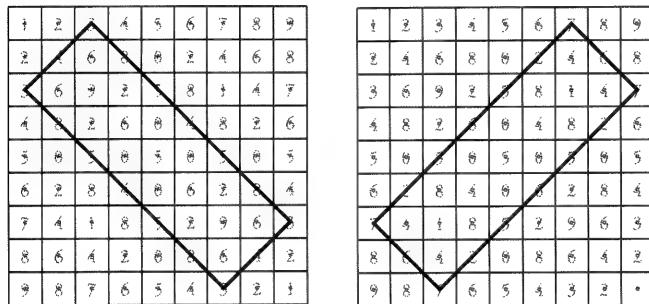
1, 2, 3, 4, 5, 6, 7, 8, 9,	0, 1, 2, 3, 4, 5,
2, 4, 6, 8, 0, 2, 4, 6, 8,	0, 2, 4, 6, 8, 0,
3, 6, 9, 2, 5, 8, 1, 4, 7,	0, 3, 6, 9, 2, 5,
4, 8, 2, 6, 0, 4, 8, 2, 6,	0, 4, 8, 2, 6, 0,
5, 0, 5, 0, 5, 0, 5, 0, 5,	0, 5, 0, 5, 0, 5,
6, 2, 8, 4, 0, 6, 2, 8, 4,	0, 6, 2, 8, 4, 0,
7, 4, 1, 8, 5, 2, 9, 6, 3,	0, 7, 4, 1, 8, 5,
8, 6, 4, 2, 0, 8, 6, 4, 2,	0, 8, 6, 4, 2, 0,
9, 8, 7, 6, 5, 4, 3, 2, 1,	0, 9, 8, 7, 6, 5,



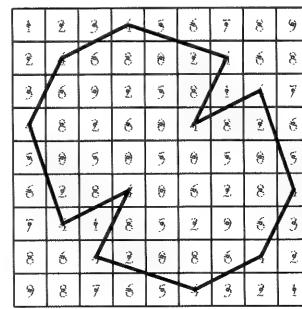
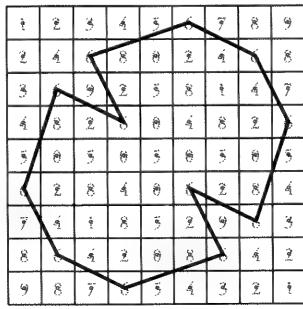
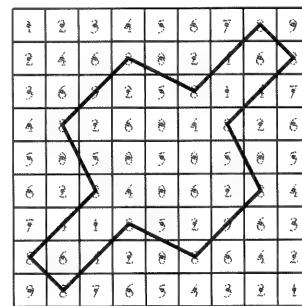
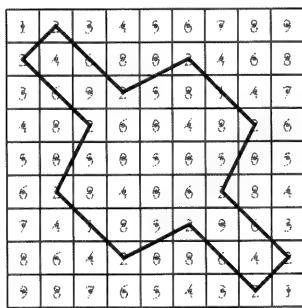
do the same thing with the four squares containing nines. These too turn out to be the vertices of a parallelogram. In fact, the parallelogram formed by the nines is the same size and shape as the one formed by the ones, but it is rotated 90 degrees about the center of the table.

Connecting the four threes and the four sevens, respectively, produces a pair of rectangles of the same size and shape, both of which are symmetric about the diagonals of the table and where again one of them is rotated 90 degrees about the center of the table.

1	2	3	4	5	6	7	8
2	4	6	8	9	1	3	5
3	6	9	2	5	8	4	7
4	8	2	6	9	1	3	5
5	9	3	8	5	8	3	6
6	8	4	9	6	3	7	2
7	4	1	8	5	2	6	3
8	6	3	2	9	8	5	4



Connecting the squares containing even digits is a bit more interesting because there are more of them. Note that there are only four squares each containing the digits 1, 3, 7, and 9. There are 9 squares containing the digit 5 and there are 12 squares containing each of the four even digits. These too form shapes that are symmetric about the diagonals of the table and where the pairs two and eight and four and six, respectively, are the same size and shape and one set of multiples forms a shape that is rotated 90 degrees.



Finally, the zeros and fives can be used to form a couple of very interesting shapes. We should note that one of the fives is located in the center square of the table, which is the intersection of the diagonals of the table, and is also the point about which the pairs of shapes have been rotated. I think the first shape pictured for zeros and fives is the most interesting

because there are no lines of symmetry, but there is 90 degree rotation symmetry. The second shape has 180-degree rotation symmetry, and just as the other shapes, this shape is symmetric about the two diagonals of the table.

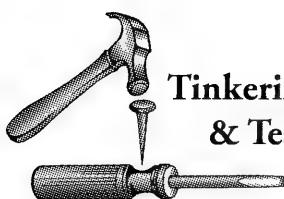
1	2	3	4	5	6	7	8	9
2	4	6	8	0	2	4	6	8
3	6	9	2	5	8	4	1	7
4	8	2	5	0	4	8	2	5
5	0	5	9	5	0	5	9	5
6	2	8	4	1	6	2	8	4
7	4	1	8	2	9	6	3	7
8	6	4	2	9	8	6	4	2
9	8	7	6	5	4	3	2	1

1	2	3	4	5	6	7	8	9
2	4	6	8	0	2	4	6	8
3	6	9	2	5	8	4	1	7
4	8	2	5	0	4	8	2	5
5	0	5	9	5	0	5	9	5
6	2	8	4	1	6	2	8	4
7	4	1	8	2	9	6	3	7
8	6	4	2	9	8	6	4	2
9	8	7	6	5	4	3	2	1

1	2	3	4	5	6	7	8	9
2	4	6	8	0	2	4	6	8
3	6	9	2	5	8	4	1	7
4	8	2	5	0	4	8	2	5
5	0	5	9	5	0	5	9	5
6	2	8	4	1	6	2	8	4
7	4	1	8	2	9	6	3	7
8	6	4	2	9	8	6	4	2
9	8	7	6	5	4	3	2	1

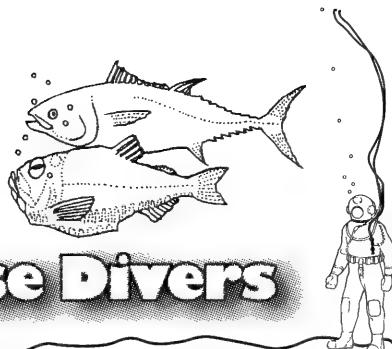
1	2	3	4	5	6	7	8	9
2	4	6	8	0	2	4	6	8
3	6	9	2	5	8	4	1	7
4	8	2	5	0	4	8	2	5
5	0	5	9	5	0	5	9	5
6	2	8	4	1	6	2	8	4
7	4	1	8	2	9	6	3	7
8	6	4	2	9	8	6	4	2
9	8	7	6	5	4	3	2	1

Sometimes we view the multiplication table as simply a place to record and reference the facts. An exploration like this one provides a way for students to make a variety of connections among the facts and within the table. The table practically takes on a life of its own as it reveals the many patterns and relationships that it holds locked within it. What a rich source of patterns and relationships that can be recorded on the number wall!



## Tinkering, Toys, & Teaching

## Diverse Divers



An important scientific principle each of us uses several times a day is known as *Pascal's principle*. Pascal's principle states that

*any change in the pressure applied to an enclosed fluid is transmitted undiminished to every part of the fluid and the walls of the containing vessel.*

The "fluid" mentioned in the principle can be either a liquid or a gas. Every time you turn on a water faucet, you are benefiting from Pascal's principle. The water pipe is a "container" filled with water under pressure. When you open the valve of the faucet, you make a "hole" in the container and water gushes out, into your glass. You use Pascal's principle to squeeze toothpaste from its tube or mustard and catsup from the plastic packets packed in your order at your favorite fast-food outlet. You may even call on Pascal's principle to remove an obstruction from the throat of a choking person (the Heimlich maneuver). Push on the brake pedal in your car and that pressure is transferred to each brake pad to stop your car. What other examples of the effects of applying pressure to an enclosed fluid can you identify?

In past columns (Volume XIV, Number 1; Volume XIV, Number 3; and Volume XV, Number 1), we have explored the behavior of a popular science toy known as the *Cartesian diver*. Our simple version of the Cartesian diver is an eyeglass floated vertically in a capped, water-filled two-liter bottle. Squeeze the sides of the bottle and the diver sinks to the bottom. Release the pressure on the sides and the eyeglass floats to the surface.

The volume of air trapped in the barrel of the eyeglass is the "life preserver" holding the diver at

the surface. By Pascal's principle, the pressure exerted on the sides of the bottle is transmitted through the water to the air bubble in the barrel of the eyeglass. This pressure decreases the volume of the air bubble (therefore the size of the life preserver) to the point the bubble can no longer float the diver. The diver sinks. When the pressure on the sides is released, the bubble expands and the diver pops to the surface.

Blaise Pascal and René Descartes were two very important and influential seventeenth century French mathematicians. Besides his pressure principle, Pascal created the mathematical foundation for modern probability theory. The Cartesian diver is apparently a misnomer because there is no direct evidence that Descartes originated the diver. But Descartes did give us the x-y coordinate system that makes it possible for us to graph algebraic and other relationships.

I've collected eight new variations on the classical Cartesian diver. Gather the following materials, and with this column in hand, head for your kitchen sink and some enjoyable water play.

### Materials

1 two-liter or 12-ounce clear plastic bottle and cap  
1 eyeglass (preferably glass)

The eyeglass must float vertically. A glass eyeglass typically does not have to be modified to make it float vertically, but you do need to wrap wire around the tip of a plastic eyeglass to get it to float vertically. (Glass eyeglasses are available from AIMS. A package of 12, catalog number 1945, costs \$3.00.)

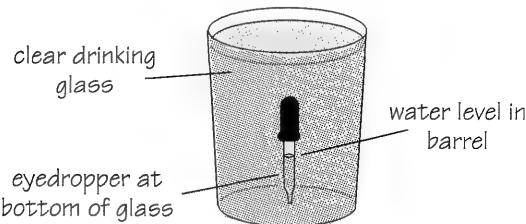
## Eight Variations on the Cartesian Diver

The Reverse Diver is one of two Cartesian diver activities in the AIMS publication *Spills and Ripples*. In the activity, the diver starts at the bottom of a flat-sided plastic bottle. When the narrow sides of the bottle are squeezed, the diver floats to the top. (Bob Benjamin, a Los Alamos National Laboratory research scientist, helped author this publication.)

### Another Reverse Diver

Susan Benjamin, Bob's wife, is a fifth-grade teacher and an AIMS trainer. Susan tinkered the following diver that illustrates the effects of a partial vacuum on the diver. This diver also starts at the bottom of the bottle.

Susan first adjusted the water in the barrel of an eyedropper so that the dropper just sinks. The easiest way to do this is to adjust the eyedropper in a tall, water-filled drinking glass. This saves you from fishing the eyedropper out of a water-filled two-liter bottle.



She then put the eyedropper in a water-filled two-liter bottle. The diver sank to the bottom of the bottle. She then squeezed approximately 10–20 mL of water from the bottle (Pascal's principle), and keeping pressure on the bottle to hold the water level at the lip of the bottle's mouth, capped the bottle. The diver now floats at the top of the bottle and behaves normally. Squeeze the bottle and it sinks; release, and it floats.

Predict what happens when the bottle is uncapped. Make the diver and check your prediction. Can you explain why the diver behaves the way it does?

### Temperature Sensitive Diver

The second variation of the diver, also suggested by the Benjamins, is the temperature-sensitive diver. This diver demonstrates that air, when heated, expands.

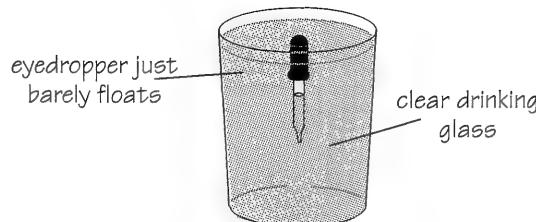
Fine-tune an eyedropper so that it just barely sinks in cold water.

Place the eyedropper in a two-liter bottle filled with warm water. If your eyedropper is properly

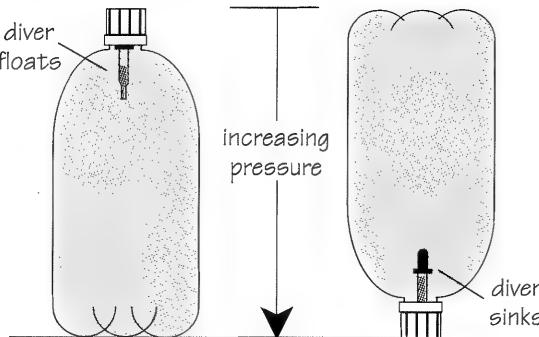
adjusted, it will sink to the bottom of the bottle. After a minute or two, as the bubble of air in the barrel of the eyedropper is heated by the warmer water and expands, the diver will rise to the top of the bottle. You don't need to cap the bottle for this demonstration.

### Diver that Floats or Sinks

Fine-tune the eyedropper so that it just barely floats.



Place the eyedropper in a full two-liter bottle. Gently turn the bottle over. Notice that the eyedropper remains at the bottom of the bottle. The eyedropper has, in effect, sunk. Gently turn the bottle over once more. Now the eyedropper is floating at the top of the bottle! The same Cartesian diver is stable in either position! How is this possible?



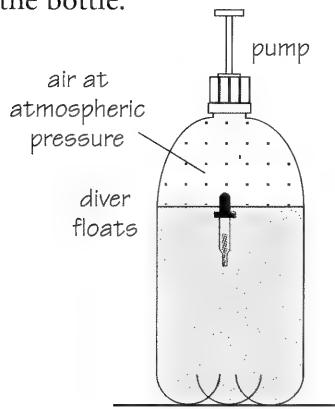
When the eyedropper is at the bottom of the bottle, the water pressure at that depth is enough to slightly compress the air bubble, thereby decreasing its volume. This lower air bubble volume holds the eyedropper at the bottom of the bottle.

When the eyedropper is floating at the top of the bottom, the pressure present at the bottom of the bottle is relieved.

### Atmospheric Pressure Diver

In the soda section at your local supermarket, you often find for sale a small air pump designed to keep opened two-liter soda bottles fresh and fizzy. The pump replaces the threaded cap of the bottle.

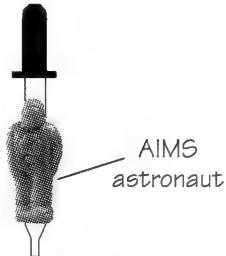
Pour water into a clean two-liter bottle until the bottle is approximately three-quarters full. Float an eyedropper at the surface of the water. Thread the pump onto the bottle.



The air above the surface of the water is at atmospheric pressure. Slowly pump air into the bottle. As you do, notice that the volume of the air bubble in the eyedropper decreases. Keep pumping. At some point, the eyedropper will sink to the bottom of the bottle. Can you apply Pascal's principle to describe what happens to the eyedropper?

### AIMS Astronaut Turned Deep-sea Diver

The modern adhesives available at almost any retail outlet make it easy to attach any suitable object to the glass barrel of an eyedropper. I used super glue to quickly attach a plastic AIMS astronaut to the barrel of a glass eyedropper. The eyedropper and its passenger easily slip through the mouth of a two-liter bottle. Model paints can be used to dress up the astronaut and make it look more like a deep-sea diver than an astronaut.



Before you glue an object to the eyedropper, test to make sure the eyedropper will support the object in water. The eyedropper has to act like a "life preserver" to keep the object floating.

This diver is great for demonstrating Pascal's principle and the actions of a Cartesian diver to large groups.

### Soy Sauce Packet Diver

I once read on the Internet a claim that the individual serving packets of condiments found at fast-food outlets made excellent Cartesian divers. Unfortunately, the specific condiments (and what

outlet to obtain them from) were unnamed. After checking every plastic condiment package I could get my hands on, I finally found one that actually makes an excellent diver. It's a packet of La Choy® Soy Sauce.

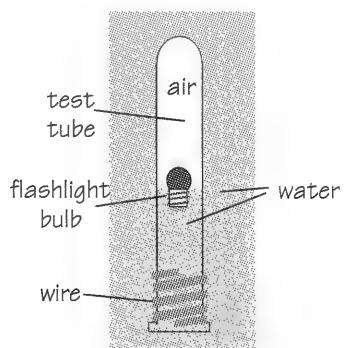


To date, La Choy® Soy Sauce packets are the only packets I've found that work as divers. If you identify any other condiment packages that make good Cartesian divers, please let me know by simply sending an email to [jawilson@fresno.edu](mailto:jawilson@fresno.edu).

### A Test Tube Diver

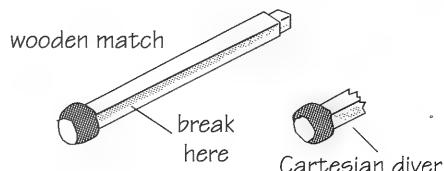
I particularly like this diver because the change in the water level in the tube is so easy to observe. The change in volume of the air bubble as pressure is applied and released is also easy to observe.

A standard test tube will slip through the mouth of a two-liter bottle. To get the tube to float vertically, wrap a few inches of wire around the mouth of the tube. Test that the tube floats vertically before inserting it into the bottle. Paint the glass envelope of a flashlight bulb. I used my wife's fingernail polish to paint the glass envelope a bright red.



### Strike Anywhere Matches

Many years ago I was shown that the head and approximately one-quarter inch of the shaft of a wooden match behaves like a Cartesian diver.



(Please see TINKERING, page 47.)

# OUR READERS

## Cryptically Challenged

The *Maximizing Math* activity in the November, 2001 issue of *AIMS®* was called "Cryptically Challenged." In this activity, students were challenged to discover every way to assign a number from zero to nine to each letter in an addition problem so that the problem was correct. Two problems were given: ONE + ONE = TWO and TWO + TWO + TWO = SIX. The first problem has 16 different solutions that were given in the original article. For the second problem, however, no solutions were given. Readers were told that there were more than twice as many solutions to the second problem than to the first, and were challenged to try and discover all of the possible solutions with their class.

We would like to thank Kate Clarisey of Milford, Ohio for sending in the excellent work of her sixth grade students from Milford Main Middle School. Mrs. Clarisey's class discovered 34 different solutions for the second challenge: TWO + TWO + TWO = SIX. The solutions discovered by her students are given below.

$$\begin{array}{cccccccc} 108 & 109 & 126 & 129 & 136 & 163 & 168 & 169 \\ 108 & 109 & 126 & 129 & 136 & 163 & 168 & 169 \\ + 108 & + 109 & + 126 & + 129 & + 136 & + 163 & + 168 & + 169 \\ \hline 324 & 327 & 378 & 387 & 408 & 489 & 504 & 507 \\ \\ 176 & 178 & 182 & 183 & 189 & 192 & 194 & 218 \\ 176 & 178 & 182 & 183 & 189 & 192 & 194 & 218 \\ + 176 & + 178 & + 182 & + 183 & + 189 & + 192 & + 194 & + 218 \\ \hline 528 & 534 & 546 & 549 & 567 & 576 & 582 & 654 \\ \\ 219 & 236 & 238 & 246 & 261 & 263 & 267 & 269 \\ 219 & 236 & 238 & 246 & 261 & 263 & 267 & 269 \\ + 219 & + 236 & + 238 & + 246 & + 261 & + 263 & + 267 & + 269 \\ \hline 657 & 708 & 714 & 738 & 783 & 789 & 801 & 807 \\ \\ 273 & 291 & 304 & 306 & 307 & 308 & 316 & 318 \\ 273 & 291 & 304 & 306 & 307 & 308 & 316 & 318 \\ + 273 & + 291 & + 304 & + 306 & + 307 & + 308 & + 316 & + 318 \\ \hline 819 & 873 & 912 & 918 & 921 & 924 & 948 & 954 \\ \\ 326 & 327 \\ 326 & 327 \\ + 326 & + 327 \\ \hline 978 & 981 \end{array}$$

## The Challenge Remains

Mrs. Clarisey's class did an excellent job, however, there is at least one more solution which has not yet been discovered. Can you and your students find any additional solutions?

Here are some more samples of the work Mrs. Clarisey's students did.

# Respond

## **Stephanie Foster**

Hannah and I worked together on the two “Cryptically Challenged” pages. On the first one we got all of the solutions, but we randomly found answers, and we didn’t have any systematic way of recording each solution. This made things difficult. On the second page, we first filled out the chart with the numbers that could represent the letters. We also added another column for numbers that wouldn’t work. We decided to do this page systematically. We started with a 1 in the ones place, and did all of the combinations. We continued increasing the ones place until we were finished. Then we went to 0 in the tens place until we found all of the solutions. That is how Hannah and I found solutions to the “Cryptically Challenged” pages.

## **Erin Grace**

I solved the math problems in a logical way. First, I figured out what numbers couldn’t be a possibility for each letter. Next, I filled in the ones place with the lowest possible number. Then, I tried the lowest possible number in the tens and hundreds place and then the next lowest possible numbers, and the next and so on. Next I repeated these steps only with the next highest possible number in the ones place. I used this method until I had used all of the possible ones place numbers.

## **Brian Wernke**

To get combinations that worked, I systematically figured out which ones worked. I started with a certain number in the ones place until I found all of the combinations for that number. Then I went to the next number and did the same thing.

## **Kenna Howat**

What I did was start with 1 in the hundreds place. I put 0 in the ones place but that doesn’t work, so I put a 1 in the ones place. That didn’t work so I used 2. I started with 0 in the tens place. I would just move the number up in the tens place. When I went all the way up to 9, I moved the number in the ones place up. When I go up to 9 in the ones place, I moved the number in the hundreds place up and I went until I was done.

## **Alicia Carter**

To find each of the problems for TWO + TWO + TWO = SIX, I kept the digit in the one’s place. For example, after I got  $261 + 261 + 261 = 783$ , I kept the 1 in the one’s place and got another addition problem:  $291 + 291 + 291 = 873$ . Then, I changed the digit in the one’s place to a 2. I got  $182 + 182 + 182 = 546$ . I kept the 2 in the ones place and got  $192 + 192 + 192 = 576$ . I did this for the digits 1-9 in the one’s place, but found that 5 couldn’t be in the ones place. Because  $5 + 5 + 5 = 15$ , O and X would both be 15, which cannot happen.

# PATCHWORK Planting

by Myrna Mitchell

## Topic

Plants need space to grow

## Key Question

How does the amount of space a plant has affect its growth?

## Learning Goals

Students will:

1. grow plants in a controlled setting and
2. observe how the amount of space a plant has affects its growth.

## Guiding Documents

### Project 2061 Benchmarks

- People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.
- Describing things as accurately as possible is important in science because it enables people to compare their observations with those of others.

### NRC Standard

- Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light. Organisms can survive only in environments, and distinct environments support the life of different types of organisms.

### NCTM Standards 2000\*

- Pose questions and gather data about themselves and their surroundings
- Recognize and apply mathematics in contexts outside of mathematics
- Count with understanding and recognize "how many" in sets of objects

## Math

Graphing

Counting

one-to-one correspondence

Measurement

linear

## Science

Life science

plants

## Integrated Processes

Observing  
Collecting and recording data  
Analyzing data  
Comparing and contrasting  
Communicating  
Controlling variables  
Inferring  
Predicting

## Materials

For each group of students:

Patchwork Planting Journal  
78 lima bean seeds  
plant box (see Management 2)  
planting soil  
string  
water  
masking tape  
trash bag, kitchen-size  
craft stick  
3- x 5-inch card  
measuring tool (see Management 6)

## Background Information

Plants need space in order to survive. The amount of space needed by a plant to perform well is a function of its size. Both the visible parts of the plant as well as its root system need space. The smaller the mature plant, the smaller the space it requires. Plants will utilize the sunlight, water, nutrients, carbon dioxide, and oxygen the space contains. If the spacing between plants is too small, much of their energy will be spent in competition rather than in production.

This activity will engage the students in an experience that requires the use of controlling, manipulating, and responding variables. The students will be investigating spacing (manipulated variable). They will examine how spacing affects the rate of growth of plants (responding variable). The student will control the aspects of the investigation that they can by using the same type of seeds and the same type of soil, and by keeping the sunlight and water as equal as they are able to.

## Management

1. Part One of this activity will take two weeks to complete. Part Two is extended observations.
2. Lids from boxes of copy paper can be used to make the planting boxes. You will need to line the

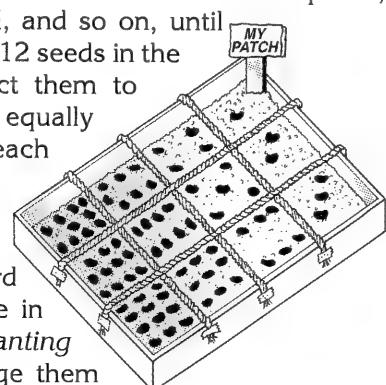
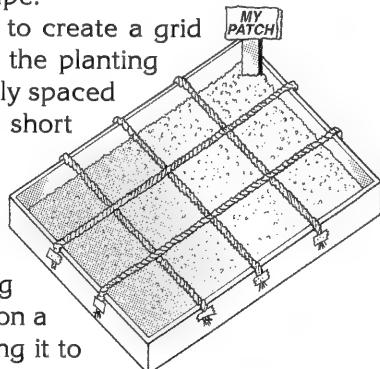
boxes with plastic to prevent water from leaking through. Large kitchen-size bags work well. Place the box lid in the bag and close it with a twist tie. Place soil in the box—soil from the yard is best; however, potting soil will do. You will need one box per group.

3. Each group will need 78 beans. Lima bean seeds are recommended because of their size and relatively rapid germination rate. You can substitute other seeds. Radish and tomato seeds germinate rapidly, but are very small and could be difficult for children to count and sort.
4. Use the *Patchwork Planting Journal* to keep a written record of students' observations.
5. Recommended group size for this activity is four students per group.
6. Students will be measuring the plant growth for comparison. You may use a tool that has uniform units such as the Unifix cubes or customary units such as a meter tape.

### **Procedure**

#### *Part One*

1. Explain how to use string to mark off four equally spaced horizontal rows along the long side of the box lid. Instruct students to tape the string in place with the masking tape.
2. Direct the students to create a grid system by dividing the planting box into three equally spaced sections along the short side of the box.
3. Have students make a marker for the first section of the grid by writing their group's name on a 3 x 5 card and taping it to a craft stick.
4. Have students plant one seed in the first patch, two in the second, and so on, until they have planted 12 seeds in the last patch. Instruct them to space the seeds as equally as possible within each patch of soil.
5. Ask students to make daily observations and record what they observe in their *Patchwork Planting Journal*. Encourage them to measure the height of the plants after germination.
6. Go over criteria for watering and sunlight exposure so that all patches will have similar conditions for these two variables.



### *Part Two*

1. Direct students to observe the plant boxes for two additional weeks.
2. Instruct students to record the height of the plants in each patch over the next two weeks. Have students continue the daily written record of the plant growth.

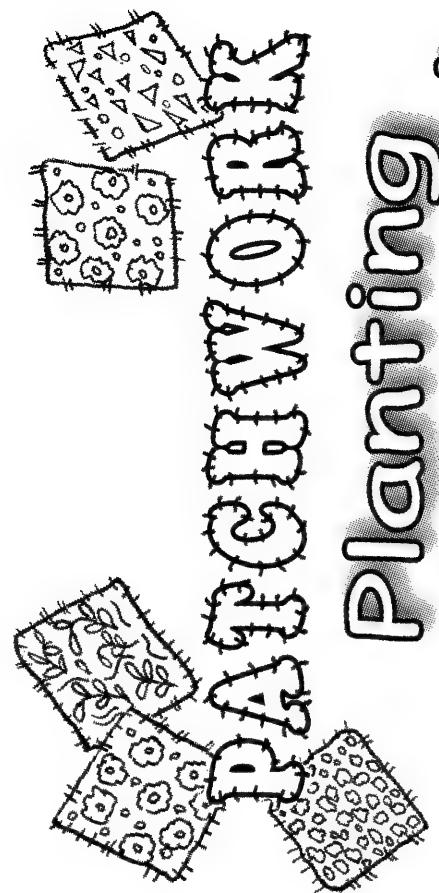
### **Discussion**

1. What did you observe?
2. Did all seeds sprout? Explain.
3. Compare how the plants looked that had more growing room to those that were crowded.
4. How does space help a plant?
5. In which patch(es) were the healthiest plants found at the end of the investigation?
6. How can we use this information to help us care for our house/classroom plants?
7. Why was it important that we water the patches all the same?

### **Evidence of Learning**

1. Check to see that the students place the correct number of seeds in each section of the grid (manipulated variable).
2. Read journals, looking for accurate observations of plant growth and for insight about the influence that space has on plant growth.

\* Reprinted with permission from *Principles and Standards for School Mathematics*, 2000 by the National Council of Teachers of Mathematics. All rights reserved.

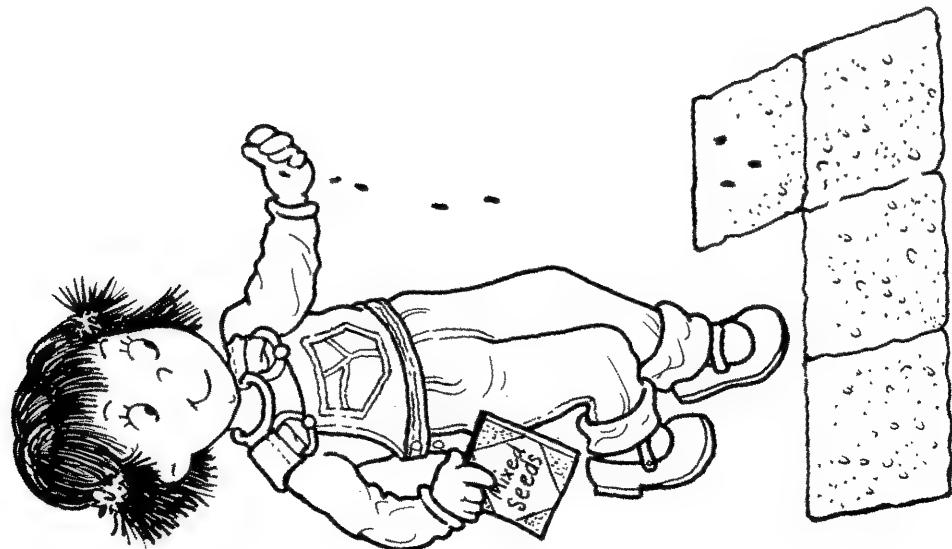


## Planting Journal



(Farmer)

fold



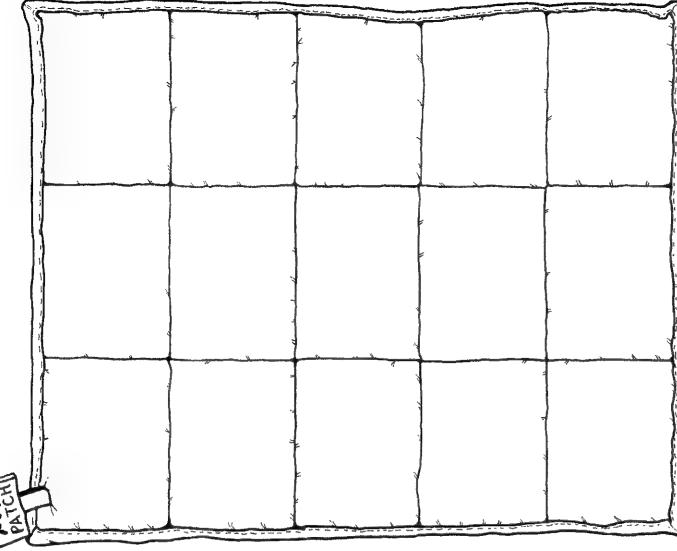
This is my patchwork garden.

Draw the seeds you planted.

Today is \_\_\_\_\_

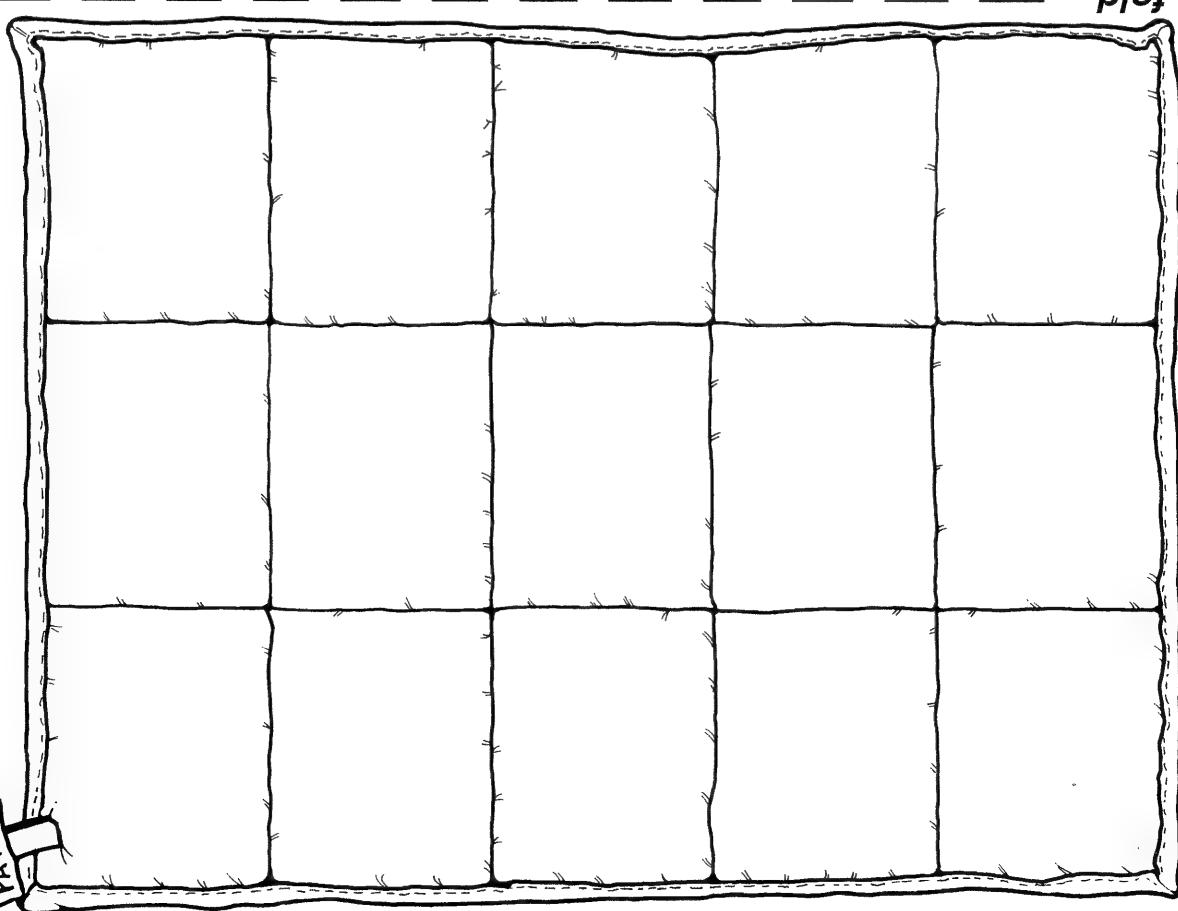
(date)

My patches look like this:



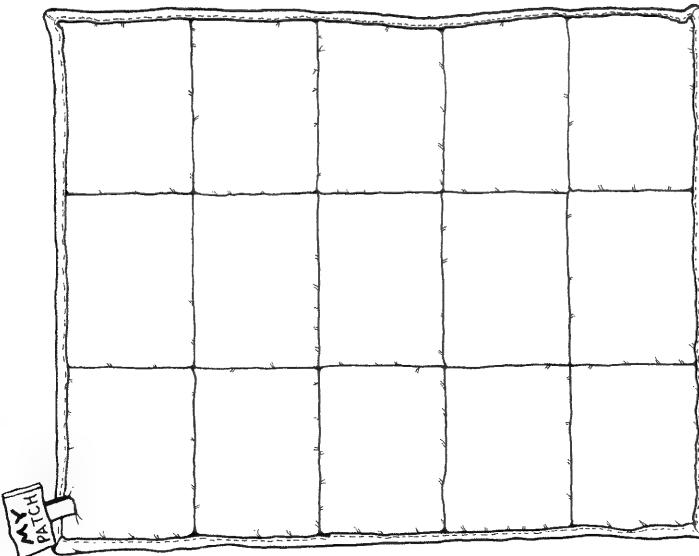
I think \_\_\_\_\_

\_\_\_\_\_ is happening.



Today is \_\_\_\_\_ (date)

My patches look like this:



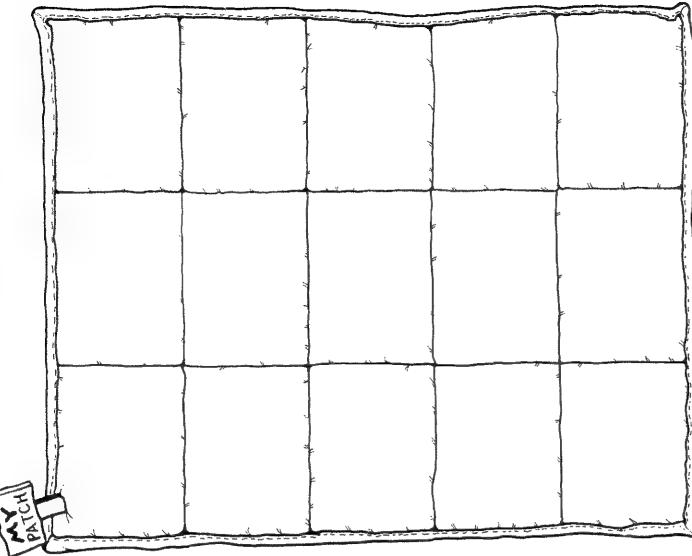
I think \_\_\_\_\_

is happening.

fold

(date)

My patches look like this:

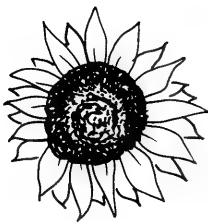


I think \_\_\_\_\_

is happening.

(date)

is happening.



# Reaching up to the Sun

by Evalyn Hoover and Sheryl Mercier

## Topic

Growth of a sunflower plant

## Key Question

How does a sunflower seed grow into a mature plant?

## Learning Goals

Students will:

1. germinate sunflower seeds, and
2. plant the seeds and observe the growth cycle.

## Guiding Documents

Project 2061 Benchmarks

- *Change is something that happens to many things.*
- *A lot can be learned about plants and animals by observing them closely but care must be taken to know the needs of living things and how to provide for them in the classroom.*

## NRC Standard

- *Plants and animals have life cycles that include being born, developing into adults, reproducing, and eventually dying. The details of this life cycle are different for different organisms.*

## Science

Life science  
plants

## Integrated Processes

Observing  
Predicting  
Collecting and recording data  
Comparing and contrasting  
Communicating

## Materials

For each group:

sunflower seeds  
transparent plastic cups, 8 oz.  
potting soil to fill the cups  
self-sealing plastic bags  
water  
paper towel

For the class:

spray bottle with water  
plastic wrap  
chart paper, optional

## Background Information

(See Information sheet.)

To germinate means to begin to grow. A sunflower seed, like all seeds, needs to absorb water until it swells and bursts its seed coat. It will take seven to 12 days for a sunflower seed to germinate. A seed contains food to support the tiny embryo. The root tip usually emerges out of the seed first. It grows rapidly absorbing water and minerals from the soil and anchors the developing seedling. Then the young stem and leaves emerge from the seed and push their way through the surface of the soil into sunlight. The leaves turn green when light reaches them and the plant begins to manufacture its own food. Sunflower plants will mature and start to flower in 80 to 90 days.

## Management

1. Get some sunflower seeds from a nursery or from a seed catalog.
2. For the first part of the lesson, each group of students will need four sunflower seeds, a plastic bag, and a paper towel. You will also need a spray bottle filled with water that the students can share.
3. For the second part of the lesson, each group of students will need a clear plastic cup, moistened soil to fill the cup, and a permanent marker to label the cups. Seeds from the first part of the lesson will also be used. Have some extra seeds on hand in case of accidents when students transfer the seeds from the seed bags to the cups of dirt.
4. The students will keep a journal throughout this activity. Copy the pages and have students cut them apart, order them, and staple along the lefthand side. You will need to give students several copies of the *Growing* page so they can record the growth of their plants every couple of weeks, depending on how fast the plants grow.
5. On the *Observing* page of the journal, the students can record their observations by either drawing pictures of the plant or writing about what they see.
6. Choose an area in the room where students can place the seeds they germinate and grow. This area should have easy access but be somewhat protected so that the seeds aren't harmed during daily activities. Once seeds have sprouted it will be necessary to have them in a location where they can get sunlight.



## **Procedure**

### *Germination of Sunflower Seeds*

1. Ask the students how many have seen a sunflower plant. Invite them to describe it.
2. Ask what they know about the growth of a sunflower seed. Wait for responses, and if desired, write the responses on chart paper. Tell the students they will be observing the growth of a sunflower plant starting from a seed.
3. Give each group of students four sunflower seeds. Provide each group with a self-sealing plastic bag, and a paper towel. Tell the students to fold the paper towel so it will fit into the plastic bag. Have them dampen the paper towel by spraying it with water. Tell them to place the seeds on the damp towel and then to slide the towel with the seeds into the plastic bag and seal it. Direct the students to put their seed bags in the designated area.
4. Ask the students why they think they were told to add water to the paper towel. Explain to the students that a seed needs to absorb water until it breaks its seed coat and the tiny embryo starts to grow sending out a root and a stem. Tell them they will watch a sunflower seed germinate—begin to grow.
5. Invite the students to observe the seeds carefully and record the growth of the seeds in their journals by drawing and writing about them as they germinate.

### *Planting the Seeds*

1. Distribute the seed bags, plastic cups, soil, and permanent markers. Have students use the marker to write their group's name on the cup. Instruct the students to fill cups with moistened soil. Then have them gently pull the paper towel and seeds out of the bag.
2. Show them how to carefully plant the sprouted seeds by placing one seed between the soil and side of the cup. This will allow the students to watch the growth of the plant's root below the soil line. Caution them to be very careful to not break off the roots or stems of the plants. If any accidents do occur, replace the damaged seed with a new seed. Discuss how this new seed will need to go through the germination process.
3. Encourage students to help each other as they plant their seeds in the cups. Ask a few students to plant extra seeds in some cups for the class or school garden. Instruct the students to record in their journals how they planted the sunflower seeds by drawing their seeds on the page *Planting*.
4. Place the cups in a sunny spot. Suggest that the students cover their cups with thin plastic wrap so that watering will not be necessary until the small sunflower plants start to grow above the soil line.

5. In about a week, uncover the cups. Caution the students to water the plants enough so they will grow but not to overwater them.
6. Provide time for the students to measure the plants' growth for about a week or until all the seedlings are growing well.
7. As the plant grows, encourage the students to predict how many days it will take for the leaves to begin to grow. Instruct the students to report in their journal the actual results and compare their observations with their classmates.
8. Have the students take their seedlings home. As a class, transplant the extras outdoors if the weather will permit their continued growth.

### *Observing the Sunflower Plant*

1. After the sunflower plant has been transplanted outdoors and is growing well, tell the students to measure the height of the plant weekly and record those measurements on the page *Growing* in their journals.
2. Ask them how many leaves they think are on the plant. Ask them if all the leaves are the same size. Have them observe and discuss where the smaller leaves are growing. Ask why they think the small leaves are located where they are.
3. What does the leaf of the plant feel like?
4. Invite the students to observe and describe the stem of the plant. Tell them to measure its height and circumference.
5. As the plant starts to bud, ask the students to describe the shape of the unopened sunflower.
6. Question the students as to which way the young plant faces in the morning. Is it different from the way it is turned in the afternoon?
7. As the sunflower plant grows, have the students predict how many days it will take for their plants to flower. Have them record their predictions in their journal.
8. Encourage the students to watch their sunflower plants and record when the plant produces a flower, when the flower opens, and when it produces seeds. Invite them to record this information in their journal on the page *Flowering*.

## **Discussion**

1. What does germinate mean?
2. How many days did it take for the first seed to sprout? Why didn't the seeds all sprout at the same time?
3. Describe the germination of your seed. What part of the new plant is first to appear from the seed? What comes next?
4. Why do you think it is important to the plant that the root grows first?
5. What helps the seed to grow?

(Please see REACHING, page 47.)

# Sunflowers

## History

The wild sunflower (*Helianthus Annuus*) is a native of North America and one of our most familiar garden plants. The American Indians in the United States have been using and cultivating the sunflower for thousands of years. Evidence suggests that they began cultivating and improving the sunflower in the Four Corners area of southwestern United States as early as 3000 B.C. It was the American Indian who first domesticated the plant into a single-headed plant with a variety of seed colors. They used the wild sunflower seeds for food and medicine. The seeds were usually roasted and ground into a meal for baking or used to thicken soups and stews. Roasted sunflower hulls were used to make a coffee-like beverage. Yellow dye, which was obtained from the flowers, and a black or dull blue dye, obtained from the seeds, were important in Indian basketry and weaving. Oil, extracted from ground-up seeds by boiling, was used for cooking oil and hair treatment. The dried stalk was used as building material.

When the early explorers came to the New World, they found that the Aztecs revered the sunflower and used it in their temples of the Sun. The sunflowers were represented in gold in these temples.

Explorers took the sunflower plant to Europe in the 1500s where it was used as a curiosity and an ornamental plant. The Russians were the first to make commercial use of the plant by manufacturing sunflower oil. By the early 1800s, Russian farmers were growing over two million acres of sunflowers. By the late 1800s, the improved Russian sunflower seed found its way back into the United States, probably by some immigrants.

## Growth

The sunflower is a tall plant with bright yellow flowers. It is an annual plant that has a rough hairy stem and grows three to 10 feet tall. The rough heart-shaped leaves are three to 12 inches long. The flower heads are composed of a disk of many small tubular flowers arranged compactly in a swirl and are surrounded by a fringe of large yellow petals that forms the rays of the composite flower. The head can be as large as 12 inches in diameter and produce up to 1000 seeds. The plant flowers from July to October.

The head of the sunflower follows the sun each day. In

the morning it faces the rising sun in the east. It follows the westward movement of the sun, so that at sunset it faces west. Sunflower in Spanish means "looks at the sun."

Sunflowers are easy to grow as long as they have sunny locations. Good fertile soil will provide for large flower heads and meaty seeds. Planting usually begins in early May with germination occurring in seven to 12 days. Plants will mature and start to flower in 80 to 90 days.

Harvest begins by the middle of September and continues into October. When the head shrivels and turns down and the seeds are ripe, the plants are cut at ground level and stood with the head uppermost like corn stalks. When dry, the seeds are removed by hitting the backsides of the heads with a mallet. The seeds are then stored in bags in a dry place. If there are just a few plants, the head can be cut with about a foot of stem attached and hung in a warm dry place. A bag can be placed over the heads to catch falling seeds as they drop during drying. Once the seeds are dried, they can be rubbed easily from the seed heads.

## Uses

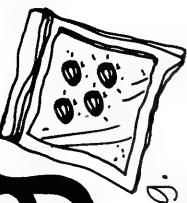
Sunflowers are more than just pretty plants; the seeds are a rich treasure of vitamins, minerals, protein, polyunsaturated fat, and fiber. Sunflower seeds contain a good amount of vitamin E, B complex, minerals, such as magnesium, iron, potassium, and calcium. There is no cholesterol! However sunflower seeds have a lot of calories, one-half cup of hulled seeds contains about 400 calories.

Economically every part of the sunflower can be used for some purpose. The leaves are used for cattle feed, the stems contain a fiber that can be used in making paper, and oil is obtained from the seeds.

Sunflower seeds provide a high-quality vegetable oil. To extract the oil, the seeds are crushed and ground to meal. The oil pressed from the seeds is of a yellow color and considered equal to olive oil or almond oil for cooking and table purposes. The residue meal cake left after the oil is pressed out forms a valuable food for cattle, sheep, pigs, and poultry.

The sunflower is one of only four major crops of worldwide importance that is native to the United States. (The other three are the cranberry, pecan, and blueberry.) There are several million acres devoted to growing sunflowers in the United States.

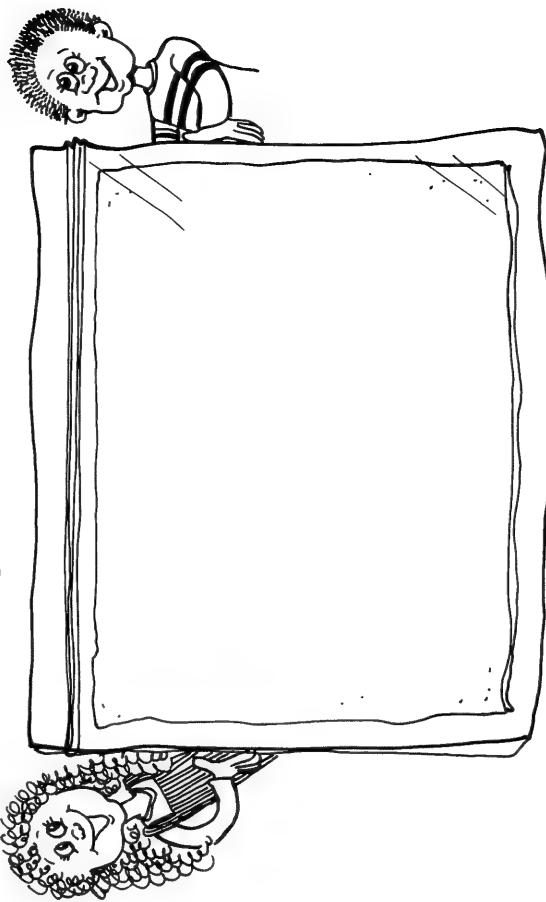
# Germinating



I put the seeds on the damp towel and close the bag.

I predict  days to germinate.

I count  days to germinate.



Here is a drawing of my seeds.

My seeds grew \_\_\_\_\_

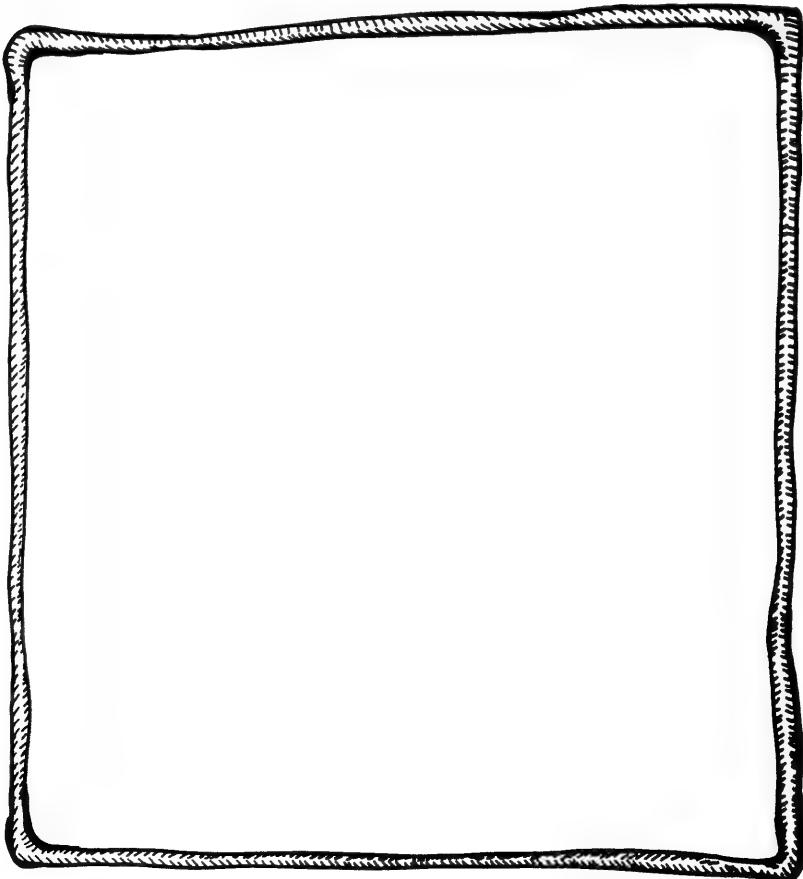
# The Story of a Sunflower

How does a sunflower seed grow into a mature plant?



# Planting

This is how I planted my sunflower seed.



# Growing

The sunflower is growing.

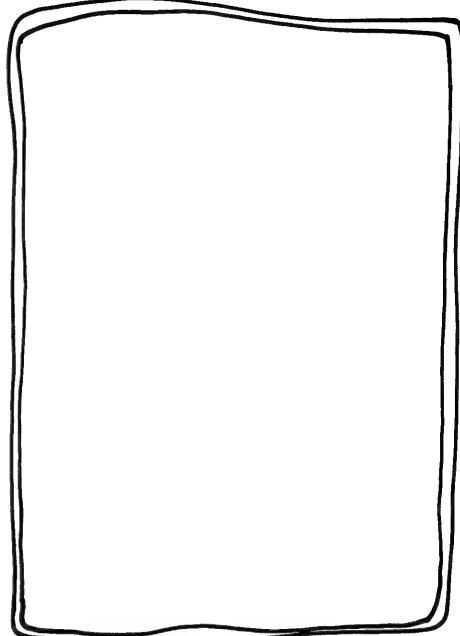
Week: \_\_\_\_\_



Height: \_\_\_\_\_



Number of leaves: \_\_\_\_\_  
Size of head: \_\_\_\_\_



Picture

I predict  days for leaves to grow.

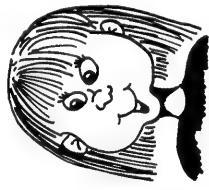
I count  days for leaves to grow.

# Observing



I observed sunflower seeds grow into a mature plant.

# Flowering

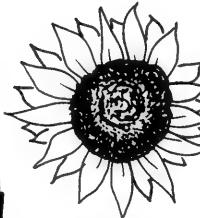


I predict the sunflower plant will flower in  days.

The plant grew a flower in  days.

The flower opened in  days.

The flower made seeds in  days.

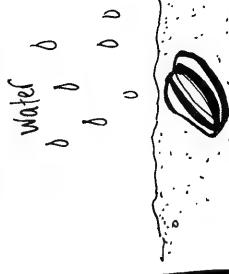


The flower

germination



Seed



fruit



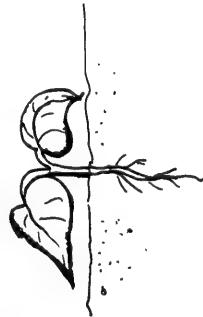
blossom



small plant



seedling



Sunflower  
Cycle



flower





## Puzzle Corner/Maximizing Math Zoo-Knowlogy

by Michelle Pauls

The *Maximizing Math* and *Puzzle Corner* activities this month are two parts of the same activity—my own variation of a mind reading puzzle. In the *Puzzle Corner* portion, students will experience the puzzle. In the *Maximizing Math* portion, they will analyze the puzzle and try to develop their own. This type of mind reading puzzle is likely familiar to you. Many versions exist, but they all follow the same basic format. You are directed to make a secret selection and then follow a series of directions given to you by the “mind reader.” For example, picking any two-digit number and then performing a series of operations on that number. With an ease and confidence that is astonishing, the mind reader is able to tell you the result of the steps you took—which number you came up with, what animal you are thinking of, which country you ended up in, etc.

In the *Puzzle Corner* portion of *Zoo-Knowlogy*, students will move markers, representing themselves, around a map of the zoo following specific directions. They will each make a decision unknown to you, yet at the end of three moves, you will be able to tell every student the exhibit at which he/she ended. (This assumes, of course, that all directions were followed properly.) Once students have experienced the trick, they will move on to the *Maximizing Math* section, where the challenge is for them to explain how it works, and then develop a similar puzzle based on the same principles. There are two versions of the *Maximizing Math* page, with *Version Two* being more open-ended than the other. Determine which page is best, based on the ages and abilities of your students.

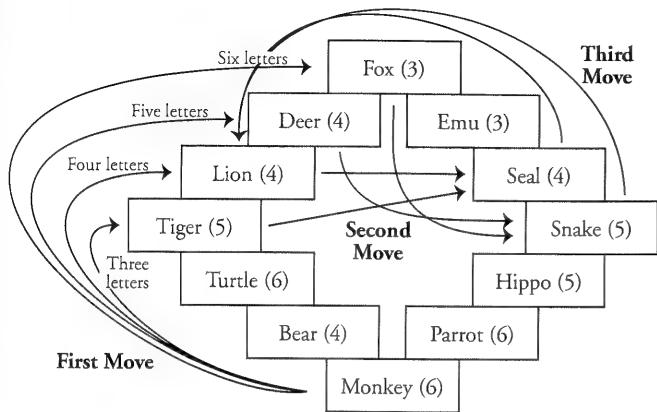
For the *Puzzle Corner* portion, each student will need a copy of the map of the zoo and a small marking chip of some kind to move around on the map. It is helpful if you make an overhead of the map so that you can give examples of how to move and clarify any questions. It will also make it more dramatic when

you place your marker on the spot that all of the students (should) end on. A page of *Teacher Directions* is provided that gives the step-by-step instructions to be read to the class. There are two versions of this puzzle, each using the same map, but different directions.

Once students have tried both versions of this activity, have them get together in small groups and hand out the appropriate *Maximizing Math* student sheet. Allow students ample time to explore the problem and develop their explanations for how it works. Conduct a class discussion in which groups share their explanations, making sure that all students come to an accurate understanding of the principles behind this puzzle.

The reason this puzzle works is illustrated here. (This explanation assumes that you are familiar with the procedure for the game, found in *Teacher Directions*.) All players begin at the monkey exhibit and pick an animal in the zoo (this is the only point at which the players have a choice). The animals in the zoo have names ranging from three to six letters in length. This means that players can end at any one of four exhibits after the first move—the tiger, the lion, the deer, or the fox. (If they pick an animal with a three-letter name, they move to the tiger exhibit; if they pick an animal with a four-letter name, they move to the lion exhibit; and so on.) For the second move, players no longer have a choice; their movements are dictated by the names of the animals at the exhibits where they are now located. Those four animals have names that are three, four, or five letters long. This results in two possible locations after the second move—the seal exhibit and the snake exhibit. Because *SNAKE* has one more letter than *SEAL*, and the snake exhibit is one exhibit past the seal exhibit, a counterclockwise move from either location will end in the same

place—the lion exhibit. The same principles are true for the second version of the game in which students begin in a counterclockwise direction. This version results in all players ending at the seal exhibit.



By using these principles and modifying the number of moves, direction of the moves, number of locations, etc., students should be able to come up with their own mind-reading games. Encourage students to be creative and come up with different settings for their games. The format can be very different from the one presented here as long as the end is known each time. Provide time for groups to develop their games and then share them with the entire class, and perhaps even other classes.

If you have student work you would like to share with us here at AIMS, we'd love to see it. Please send it to my attention care of AIMS: PO Box 8120, Fresno, CA 93747. I hope you and your students find these experiences challenging and fun. We'll be back next month with another *Maximizing Math* and *Puzzle Corner*.

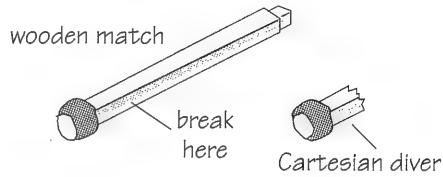
#### (TINKERING, cont. from page 31)

The wood fibers at the broken end of the match trap small air bubbles. When the two-liter bottle is squeezed, the pressure decreases the volume of these bubbles and the match head sinks. When the pressure is released, the volume of the bubbles returns to normal and the match head floats. Eventually the air bubbles escape from the fibers and the diver no longer works.

Because the Cartesian diver is so popular with students, I've been collecting the science concepts that can be connected to the diver. The more science concepts teachers and students explore when playing with a Cartesian diver, the richer the diver becomes

as an object for thinking. If you would like a graphic representation of the seven science concepts that can be taught and learned by playing with a Cartesian diver, email your request to [jawilson@fresno.edu](mailto:jawilson@fresno.edu).

I will continue to tinker with the Cartesian diver. Every time I think I've learned all there is to know about the diver, I'm surprised to learn something new.



In the next column I will start a continuing series of electrical circuit projects. Each project will be built on a special board called a "breadboard." I will begin by constructing the important early twentieth-century electrical circuits and eventually complete the series by constructing a few simple twenty-first century circuits.

#### (REACHING, cont. from page 47)

6. How long did it take for the first leaves to appear on the plant? What do the leaves do for the new plant?
7. Why do you think some seeds grew faster (or slower) than others?

#### Extensions

1. Suggest to the students that they continue to record in a journal the growth and flowering of their sunflowers. Encourage them to especially watch the heads of the plants as they tend to follow the direction of the sun.
2. Other activities that deal with seeds can be found in the AIMS publications *Winter Wonders*, *Primarily Plants*, and *Budding Botanist*.

#### Home Link

Copy the sheet showing the growth cycle of a plant. Send it home with the students. Encourage the students to cut the picture cards apart, put them in the correct order, and explain to their parents how their sunflower seed grew.

#### Evidence of Learning

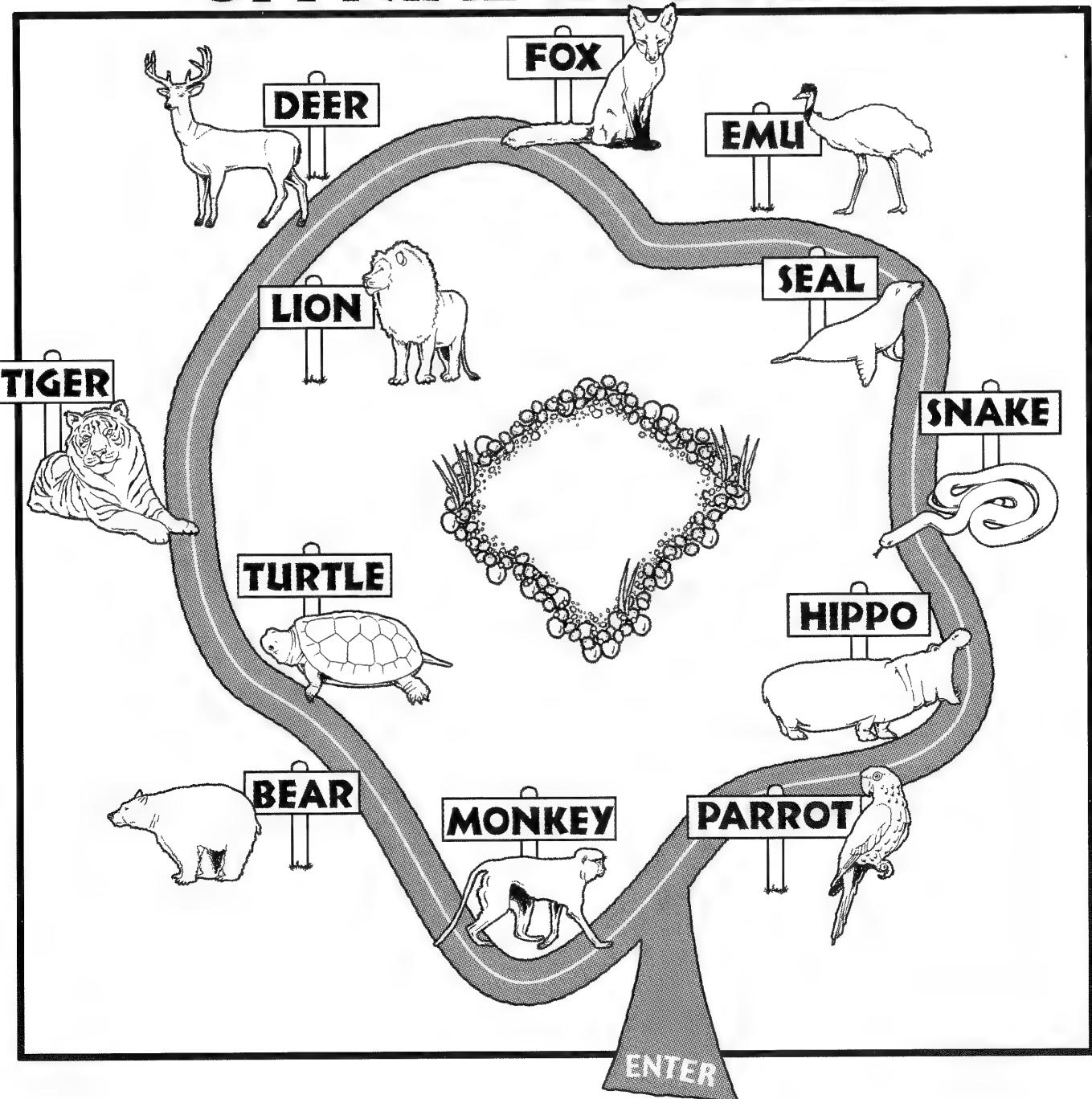
Students should be able to explain how their seeds germinated. They should explain after the seed absorbed water, the root emerged first, then the stem and leaves.

# ZOO-KNOWLOGY

## Puzzle Corner

You are going to take a trip around the zoo using the map below. Carefully follow the directions your teacher gives you and move your marker around the zoo. You must stay on the path.

## OFFICIAL ZOO MAP



# ZOO-KNOWLOGY

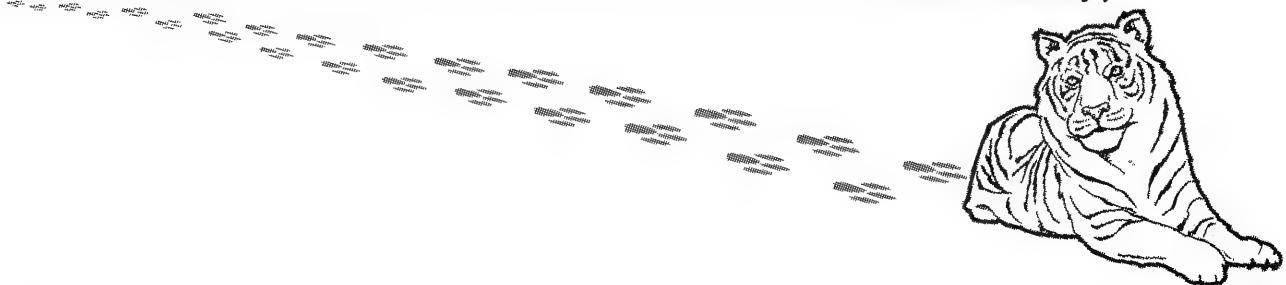
## Puzzle Corner—Teacher Directions

### Version One

1. We're going to take a trip around the zoo beginning at the monkey exhibit. Place your marker there.
2. Choose any animal in the zoo, but don't tell anyone which animal you picked. Spell out the name of that animal, moving around the zoo one exhibit for every letter in the name. Move in a **clockwise** direction. Do not count the space where you are starting. For example, if you picked "Emu," you would end up at the tiger exhibit. (Show how to move the marker around the zoo, spelling out the name of an animal. Emphasize the clockwise direction and the accurate spelling of the name.)
3. Spell the name of the animal at the exhibit where your marker ended, again moving around the zoo in a **clockwise** direction. If you were starting from the tiger exhibit, you would now be at the seal exhibit.
4. Spell the name of the animal at the exhibit where your marker ended once more, this time moving in a **countrerclockwise** direction. (Be sure that all students pay attention to this change in direction.)
5. I will now go to the exhibit where you are and meet you there. (Place your marker on the lion exhibit. All students will be there if they have moved their markers correctly.)

### Version Two

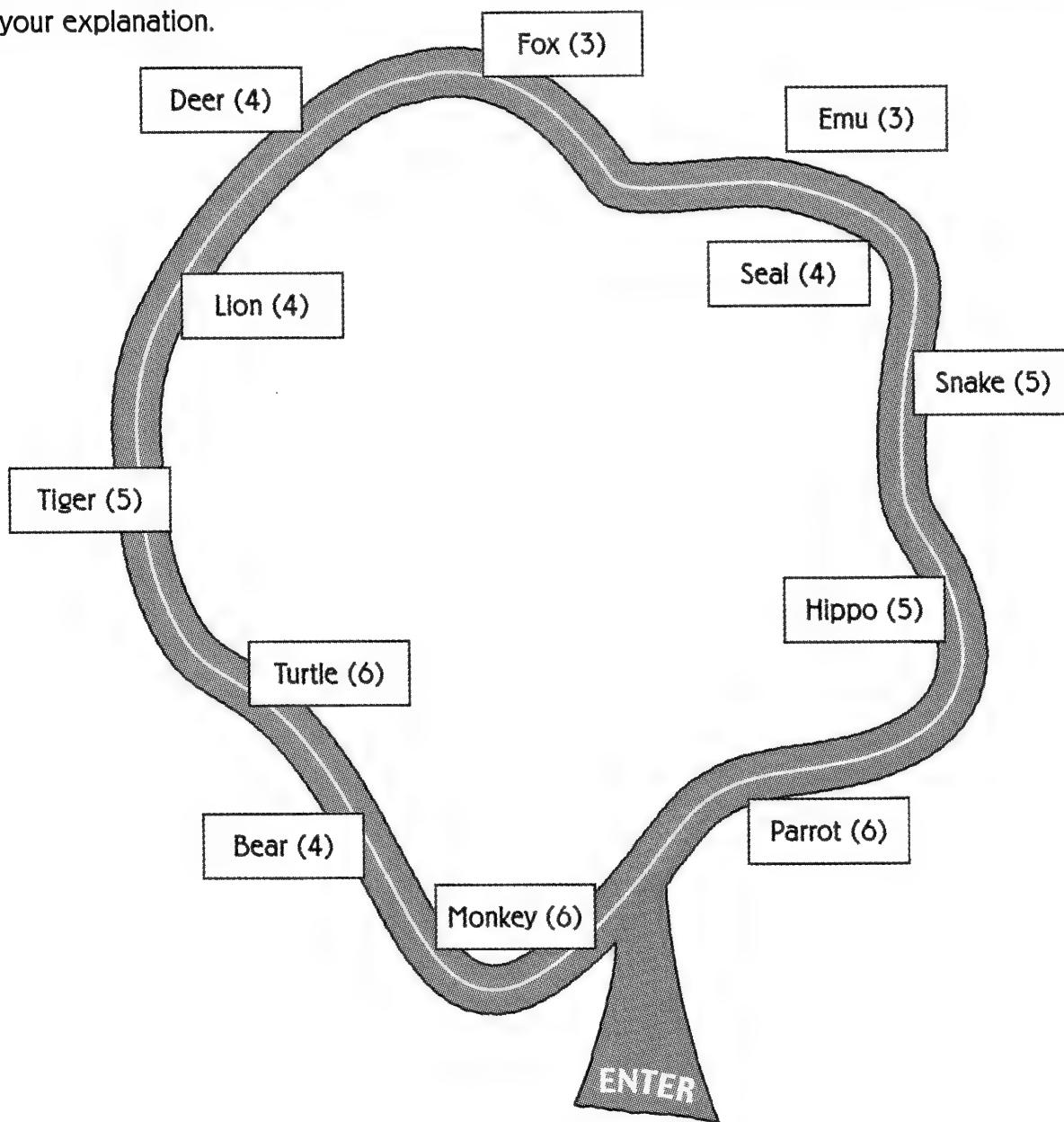
1. Let's take another trip around the zoo, once again beginning at the monkey exhibit. (Have students place their markers at the monkey exhibit once again.)
2. We're going to follow the same rules as before, but this time, when you pick your animal, move your marker around the zoo in a **countrerclockwise** direction, spelling out that animal's name. (Be sure all students begin moving their markers in the correct direction.)
3. When you get to the second animal, continue to move in a **countrerclockwise** direction, spelling out this second animal's name.
4. For the final move, spell the third animal's name while moving **clockwise**.
5. I will once again join you at the exhibit where you have finished. (Place your marking chip on the seal exhibit. All students will be at there if they have moved their markers correctly.)



# ZOO-KNOWLOGY

## Maximizing Math—Version One

- How did your teacher know what exhibit you were at by the end of each trip? Study the diagram below to help you develop an explanation for why it works. Notice that the number of letters in each animal's name has been included. Use the back of this paper to record your explanation.

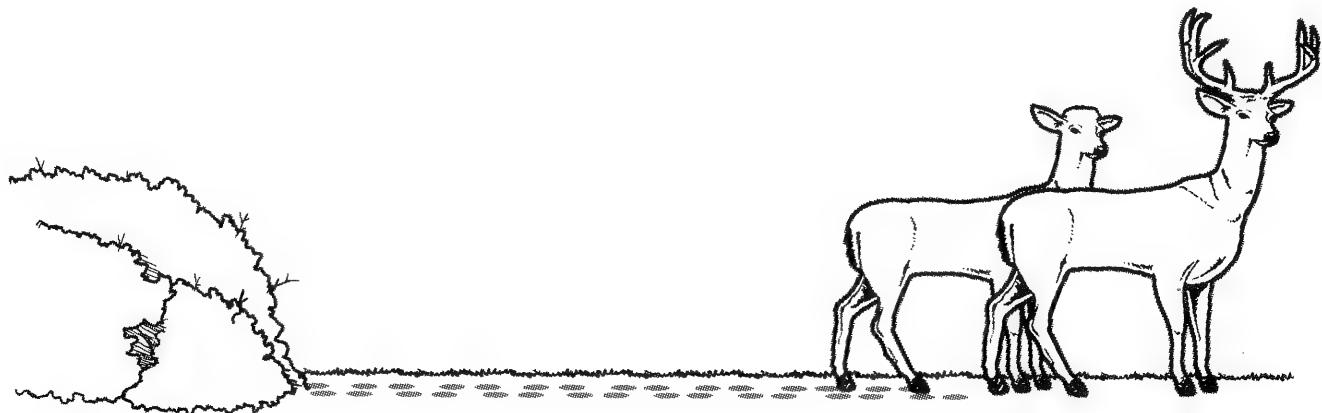


- As a group, come up with a similar puzzle in which you will always know the answer or the final result. Your new puzzle can have a very different format as long as you always know how it will end. Be prepared to share your puzzle with your classmates.

# ZOO-KNOWLOGY

## Maximizing Math—Version Two

1. How did your teacher know what exhibit you were at by the end of each trip? Study this problem and develop an explanation for why it works. You can use words and/or diagrams to describe your answer.
2. As a group, come up with a similar puzzle in which you will always know the answer or the final result. Your new puzzle can have a very different format as long as you always know how it will end. Be prepared to share your puzzle with your classmates.



# MAGNETIC MANIPULATIONS

by Dave Youngs

## Topic

Magnetic force

## Key Question

How can you use your senses to experience the magnetic force?

## Learning Goal

Students will explore and experience the magnetic force qualitatively by using their senses of feeling and seeing.

## Guiding Documents

### Project 2061 Benchmark

- Without touching them, a magnet pulls on all things made of iron and either pushes or pulls on other magnets.

### NRC Standard

- The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as a change in the environment). Humans and other organisms have senses that help them detect internal and external cues.

## Science

### Physical science

force  
magnetism

### Life science

senses

## Integrated Processes

### Observing

Comparing and contrasting

## Materials

Ring magnets, two per student

Hand lens, one per student

## Background Information

Magnetism is one manifestation of a fundamental force in the universe—the electromagnetic force. Some of the important properties of this fundamental force, in its magnetic form, can easily be observed by elementary school students using their senses of feeling and seeing.

One of the key characteristics of the magnetic force is that it is able to act at a distance and make things move, without coming in direct contact with those objects. In addition, when in the presence of

another magnetic field, this force both attracts and repels; depending, respectively, on whether unlike or like poles are next to each other. In these two important ways, this force is very different from the normal pushing and pulling forces we encounter in our everyday experience.

## Management

- Caution:** Magnets can damage things like computer monitors, floppy disks, and audiotapes. Be aware of this when doing the activity and take any necessary precautions.
- Ring magnets are available from AIMS, catalog number 1971.
- This activity has two parts that can be completed in one class period. Each part can be done with the whole class or in small groups, depending on how many magnets you have. In either case, it is imperative that students have their own ring magnets so that they can experience the magnetic force firsthand.
- Ring magnets fascinate students. If this is your students' first experience with ring magnets, build in ample free exploration time before starting the activity. Otherwise, students may have a hard time focusing on the activity.

## Procedure

### Part One

- Hand out the magnets and the first student sheets.
- Ask, *How can you use your sense of feeling to experience the magnetic force?*
- Have students follow the directions on the student sheets. After they do each section, lead them in a discussion and have them record their answers.

### Part Two

- Hand out the student sheet.
- Ask, *How can you use your sense of seeing to experience the magnetic force?*
- Have students follow the directions on the student sheets. After they do each section, lead them in a discussion and have them record their answers.
- Conclude the activity with a whole class discussion that focuses on how students used their senses of feeling and seeing to observe the magnetic force in various ways. If appropriate, discuss the magnetic force in greater detail.

## **Discussion**

### *Part One*

1. What did you feel when you moved the magnets near the steel object? [There was an attraction between the magnets and the steel object that pulls them together.]
2. How did the attraction change the closer you got to the steel object? [The closer the magnets, the stronger the attraction.]
3. What did you feel when you pulled the magnets away from the steel object? [The magnets wanted to stay attached to the steel. This attraction or pull was strongest when the magnets and steel were touching or near each other.]
4. What did you feel when you held the magnets just above the steel object? [The attraction or pulling force was quite strong, making it difficult to hold the magnets in this position.]
5. From this experience of bringing your magnets near steel objects, what can you say about the magnetic force? [There is an attraction, or pull, between magnets and steel objects. This pull is greater the closer the two are to each other. This force acts at a distance.]
6. How does what you felt when pulling apart the stacked magnets compare to pulling the magnet away from the steel object? [The attractions felt the same.]
7. What did you feel when you flipped one of the magnets over and then brought them together. [There was a repelling, or pushing, force exerted by the magnets.]
8. How was what you felt with the magnets like normal pushing and pulling forces? [The magnets either pulled or pushed on each other when brought together.]
9. How was what you felt with the magnets different from normal pushing and pulling forces? [The magnets exerted their pulling or pushing forces at a distance, without making direct contact.]

### *Part Two*

1. What did you see when you put the two magnets flat on your desk and tried to push one near the other? [In this orientation (like poles near each other), the ring magnets repelled each other, and the second magnet was pushed away by the first.]
2. What did you see when you flipped one of the magnets over and brought the other magnet close to it? [The two magnets attracted each other and the second magnet slid and joined the first.]
3. What did you see when you held one magnet directly above the other (in an orientation with unlike poles facing each other) and slowly lowered this magnet? [When the lowered magnet was a few centimeters above the magnet on the desk, the magnet on the desk jumped up and attached to the lowered magnet.]

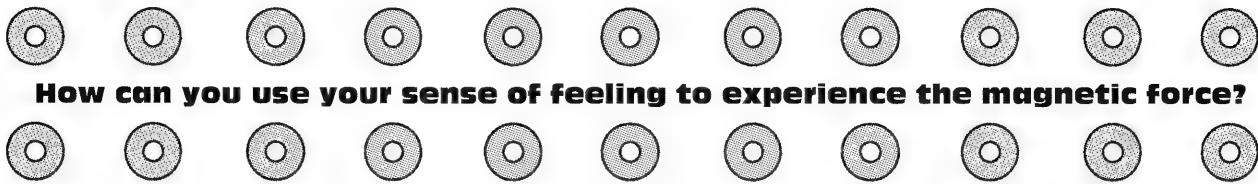
4. What did you see when the magnets were held together (when they were oriented so that they repelled each other) and the top magnet was released? [This magnet shot off into the air. It may have flipped over and reattached itself to the bottom magnet.]
5. What does the material of the ring magnet look like? [It has a dark gray color that looks slightly mottled with alternating dull and shiny specks. The material looks fairly homogeneous. There may be some tiny cracks visible through a hand lens.]
6. Can you see a difference between the two flat sides of the magnet? [No, the sides are not noticeably different.]
7. Although there is no noticeable difference between the sides of the ring magnet, they act very differently. What does this tell you about the magnetic force? [The visually homogeneous magnetic material has invisible differences that cause the magnets to either attract or repel each other, depending on how they are oriented.]
8. What have you learned about the magnetic force from doing the experiments in this activity? [Magnets pull on steel, or other magnetic materials. Magnets either pull or push on each other, depending on their orientation. The magnetic force can cause things to move by pushing or pulling on them. The magnetic force acts at a distance and does not need to be in direct contact to push or pull on an object. The magnetic force is stronger the closer the magnet gets to another magnet or to magnetic material. Although magnetic material appears to be homogeneous, there are invisible differences between the flat sides of the ring magnets.]

## **Extensions**

1. Have students experiment to see what other materials are attracted to their magnets.
2. Have students build a system using magnets which overcomes the force of gravity.

# MAGNETIC MANIPULATIONS

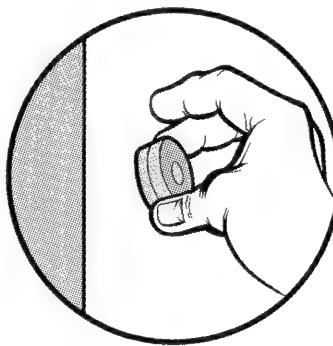
## PART ONE: FEELING THE FORCE



**How can you use your sense of feeling to experience the magnetic force?**

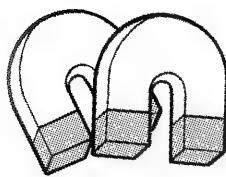
Stack two ring magnets and hold them so one of the flat surfaces is facing forward. Slowly bring them near the side of your desk, leg of your chair, or some other large steel object until they touch and stick. What did you feel when you did this? How did what you felt change as you got closer to the steel object?

Slowly pull the magnets away from the steel object. Describe what you felt this time.

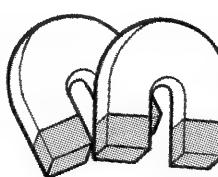


Hold your magnets just above the surface of the steel object without letting them touch the steel. Describe what you felt.

You have experienced the magnetic force as you brought your ring magnets near to something made of steel. What can you say about the magnetic force as a result of this experience?



# MAGNETIC

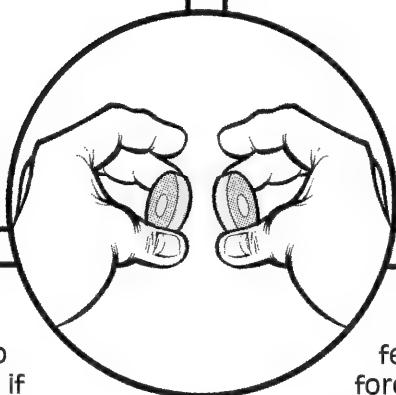


# MANIPULATIONS

PART ONE: FEELING THE FORCE  
(continued)

Stack the ring magnets. Grab one magnet in each hand and slowly pull them apart. What did you feel when you did this? How did this compare with what happened when you pulled the magnets off the steel object?

Stack the magnets once more and then pull them apart. Flip one of the magnets over. Slowly bring the two magnets together. What do you feel? How does this compare with what happened when you brought your magnets close to the steel object?



Forces are pushes and pulls that can make things move. Most pushes and pulls require things to be in direct contact. For example, if you push on a door or pull on a lamp cord, your hand—which is supplying the force—must be in direct contact with these things. How is what you experienced in this activity like pushing on a door or pulling on a lamp cord? How is it different?

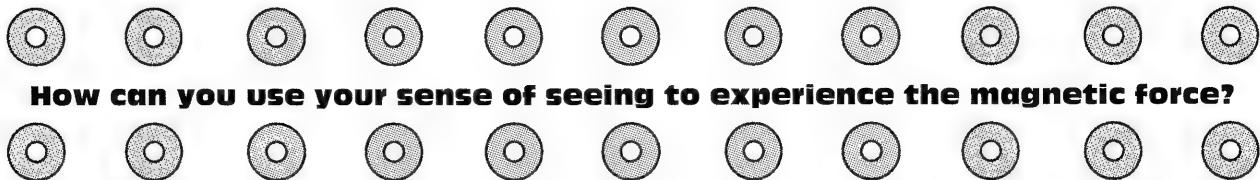
In this first part of the activity you have used your sense of feeling to experience the magnetic force. This force is able to act at a distance without making direct contact with an object. How did this investigation demonstrate this?

What else can you say about the magnetic force from this experience?



# MAGNETIC MANIPULATIONS

## PART TWO: SEEING THE FORCE



**How can you use your sense of seeing to experience the magnetic force?**

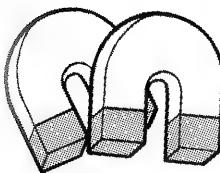
Place two stacked ring magnets on your desk or another flat surface. Pull the top one off and put it flat on the desk a little ways away. Slowly push one magnet close to the other. What do you see?

Flip one of the magnets over and slowly push it close to the other. What do you see this time?

Stack the magnets on your desk. Pull the top one off and hold it about ten centimeters above the other. Slowly lower it and watch what happens. What did you see?

Orient your magnets so they repel each other. Force them together and hold them with your fingers. Let go of the top magnet. What happens?

Think of some other experiments you can do with your magnets. Do a few of these experiments and describe what you see in each case.



# MAGNETIC MANIPULATIONS

## PART TWO: SEEING THE FORCE

(continued)

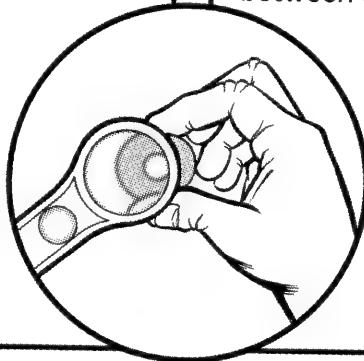


**In the experiments on the last page, you saw the magnetic force in action. The two ring magnets either repelled or attracted each other, depending on the orientation of their flat sides.**

**Take time now to closely examine one of your ring magnets. Use a hand lens if you have one available.**

What does the material of the ring magnet look like?

Closely examine both flat sides of the ring magnet. Can you see a difference between the two sides?

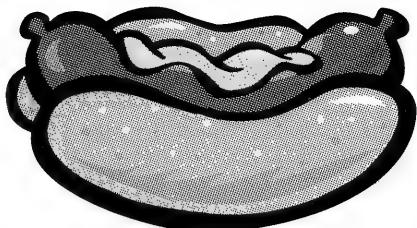


Although the ring magnet material looks the same and there is no visible difference between the two sides, these sides are obviously different. What does this say about the magnetic force?

In this activity you have used your senses of feeling and seeing to experience the magnetic force. Summarize what you have learned about this force from doing this activity.

# The Teachable Moment

by Suzy Gazlay



## Hot Dogs

**H**ot dogs seem to belong particularly to the summer months: baseball games, Memorial Day and Fourth of July picnics, wienie roasts around a campfire. Some people slather them with toppings, while others settle for a dab of ketchup or mustard, if anything at all. Whatever the preferences for preparing and eating them, hot dogs are very much a part of our culture.

Where did hot dogs come from? Did they gradually progress into their present form, or were they the result of someone's brilliant idea? When were they first made and eaten? As is so often the case, the origin of hot dogs (and their close relative, sausages) is disputed, and folklore versions abound.

We do know that sausages are one of the oldest forms of processed food. They were mentioned in Homer's *Odyssey*, so they date at least as far back as the 9<sup>th</sup> century B.C. Hot dogs arrived considerably later. Three different cities claim credit as their birthplace. Two left their mark with familiar names: Frankfurt-am-Main in Germany—hence the name *frankfurter*—and Vienna, Austria. The German name for Vienna is *Wien*, which accounts for *wiener*. The third claim comes from Coburg, Germany where a local butcher named Johann Georghehner created the first hot dog during the late 1600s. He later traveled to Frankfurt to promote his new type of food. However, citizens of Frankfurt maintain that frankfurters were already well established there and had been since 1484.

German immigrants brought their sausages and franks with them when they came to the United States during the 1800s. The frankfurters were called *dachshund sausages*, probably as a joking reference to the Germans' long, thin little dogs. Germans generally ate their sausages with bread, probably the origin of serving them with a roll. Again, it's not clear who was first to market the dachshund sausages in a bun. According to one report, the original hot dog and roll combos were sold by a German immigrant from a pushcart in New York's Bowery during the 1860s. We do know that in 1871, another German butcher named



Charles Feltman opened the first hot dog stand on Coney Island, selling 3684 dachshund sausages in the first year.

In 1883, thousands of visitors attended the Columbian Exposition in Chicago. Dachshund sausages were an immediate hit with a crowd that appreciated a food that was so convenient and inexpensive. That same year, sausages became established at baseball parks, likely due at least in part to the efforts of Chris Von de Ahe, a German immigrant who owned the St. Louis Browns team.

Another explanation, less credible because of the dates, still makes a good story. This version explains that a Bavarian vendor named Anton Feuchtwanger gave out white gloves for folks to handle the hot sausages he sold at the St. Louis Exposition of 1904. Unfortunately, the gloves weren't all returned, so his brother-in-law, who was a baker, came up with long, thin rolls to hold the sausages.

The source of the name we most often use, *hot dog*, is also debatable. Several versions exist. One of the most common—and least likely—explanations involves Tad Dorgan, a popular sports cartoonist for the *New York Journal*, who happened to watch a vendor selling hot dachshund sausages at the New York Polo Grounds in 1901. As the story goes, Dorgan drew a cartoon of barking dachshunds tucked into rolls. He wasn't sure how to spell "dachshund," so he just wrote "hot dog." The story says that the cartoon was a sensation and the name stuck. The main problem with this version is that no one, not even Smithsonian historians, has ever been able to find the cartoon.

The name "hot dog" started appearing in college magazines beginning in 1895, referring to "dog wagons" from which hot dogs were sold at college dorms. One of the most popular stands was even nicknamed "The Kennel Club." Since even the Germans called their frankfurters a "little dog" or "dachshund" sausage, the connection was probably made between the German and English names.

Today's hot dogs come in a wide range of sizes, tastes, and ingredients. All hot dogs are cured and cooked before they are marketed. Until recently, the meat content was most often pork, beef, or a combination of the two, but now chicken, turkey, and meat/poultry blends are becoming more in demand. Water and curing agents are added, as well as salt, sugar, and spices such as garlic, pepper, coriander, nutmeg, and ground mustard. Rumors and legends abound regarding the contents of hot dogs, but they are actually made of trimmings of the same types of meat or poultry as is sold at any butcher counter. Like all processed meats, hot dogs must meet certain government standards. By law, a hot dog can contain up to 3.5% of "non-meat ingredients," but this does not mean that they contain anything weird. The non-meat ingredients are usually a milk or soy product added for nutritional value. Any "variety meats" used, such as hearts or kidneys, must be listed specifically on the label. Like most meat products, hot dogs contain protein, iron, and various vitamins, but they tend to be comparatively high in fat, sodium and, of course, certain preservatives.

The process of making a hot dog may take as little time as a couple of hours. The procedure begins with meat or poultry trimmings that are ground into very small pieces in a high-speed chopper, along with measured spices, curing ingredients, and ice chips. The mixture is continuously weighed for proper balance as it is blended. The resulting batter is pumped into an automatic stuffing and linking machine where it flows into long cellulose casings. The encased batter is divided into precisely measured hot dogs linked together. The links move on a conveyor belt through the smokehouse where they are fully cooked and smoked under conditions of controlled humidity and temperature. Some may be smoked with hardwood to create a special flavor. Next comes a cool water shower, after which the cellulose casing is stripped off by an automatic peeler, leaving individual franks. If the casing is "natural"—cleaned and processed animal intestines—it is not removed. Next the hot dogs are conveyed to the

packaging line. Any franks that are off weight are diverted. The rest move into vacuum packaging machinery to be grouped, sealed in plastic film, and labeled. Finished packages go to a storage cooler and then to a refrigerated truck for delivery.

## Interesting Facts

- In the year 2000, Americans ate more than 20 billion hot dogs. An estimated seven billion franks will be eaten this year between Memorial Day and Labor Day, including two billion in July, with 150 million devoured on the Fourth of July alone.
- In 2000, 987 million pounds of beef and pork and 83 million pounds of chicken and turkey went into franks sold in retail stores. Consumers in Los Angeles bought the most wieners by weight: 39,019,128 pounds.
- The combined market for hot dogs and sausages, wholesale and retail, is more than \$23 billion. New Yorkers (city) spent the most money on them: \$89.5 million.
- Easterners eat more all-beef dogs, and Westerners eat more poultry dogs than the other regions of the USA.
- Hot dogs are served in 95% of American homes, with each American consuming an average of about 60 hot dogs a year.
- Around 26.8 million hot dogs were consumed at major league baseball stadiums in 2001. The home stadiums of the Cleveland Indians and the Los Angeles Dodgers vie for the honor of selling the most hot dogs in a given year. Also in 2001, Miller Park Stadium in Milwaukee sold more variety sausages than hot dogs, the only time that hot dogs have ever come in second.
- Fifteen percent of all hot dogs sold are bought from street vendors. Nine percent are purchased at ball parks.
- A hot dog eating contest has been held on Coney Island every Fourth of July since 1916. Competitors come from around the world and must first win regional contests to qualify. Whoever eats the most franks in 12 minutes gets a trophy, a year's supply of hot dogs, and a Mustard Yellow International Belt. The current record holder (2001) is 23-year-old Takeru Kobayashi of Japan, who gulped down 50 hot dogs in 12 minutes. He weighed in at 131 pounds.
- According to a poll of congressmen taken in 2000, 73% of the Republicans and 47% of the Democrats prefer mustard on their hot dogs. Ketchup is preferred by 17% of the Republicans and 35% of the Democrats. The rest either have other preferences or are undecided. President George W. Bush prefers mustard and relish.
- In July of 1996, Operation Wienerlift delivered more than 37,000 hot dogs, 700 pounds of mustard, and 3500 pounds of beef summer sausage to the American troops stationed in Bosnia.
- An Internet poll of nearly 1000 devoted hot dog fans showed that 23% would serve hot dogs at their own wedding reception.
- Hot dogs have recently become part of the Russian culture and are eaten for breakfast, lunch, or dinner. Russians prefer chicken or turkey franks. They like their hot dogs spicy, so franks manufactured for Russia contain a lot of garlic.
- A new market for hot dogs is developing in China. A favorite treat is a single cold frank wrapped in red plastic and eaten like a popsicle. Increasing in popularity is a warm hot dog served on a stick, without bread. The Chinese also prefer chicken or turkey franks, but they like them sweet.
- Nearly four of every ten baseball fans at a major league stadium will eat a hot dog. In baseball terms, that's a batting average of .379.
- Low-fat and fat-free hot dogs hit the market in the 1990s and now account for 10-15% of total sales. Regular wieners typically have 13 to 17 grams of fat and 150 to 190 calories.

- Between games of a double header, Babe Ruth once ate 12 hot dogs and drank eight bottles of soda. He landed in the hospital with severe indigestion.
- A restaurant on Martha's Vineyard sometimes serves hot dog ice cream.

## Things to Do

- Hot dog problems: How many different combinations are possible if just two of the following toppings—ketchup, mustard, relish—are added to a hot dog? How many are possible if cheese is added to the choices? What if a fifth choice, chopped onions, is added to the possibilities?
- According to various polls, the most popular single topping for hot dogs is mustard, but most people seem to like a combination of ketchup, mustard, relish, onions, sauerkraut, and chili. Some people even like chocolate! Take a survey to find out the preferred toppings in your class. Find the preferences of your family members, other classes, the school staff. Chart your data and see how the choices of the different groups compare to each other and to the national data (see *Internet Connections*).
- Russian hot dogs may be served wrapped in a single slice of bread, or perhaps stuffed into a hole drilled into a long, thin loaf of bread. Chinese hot dogs are sometimes sliced and fried in butter or eaten like a popsicle. In Sweden, hot dogs are wrapped in bread and topped with a big scoop of mashed potatoes. What other ways can you think of that hot dogs might be served? Be creative! Write a commercial to advertise your special hot dog.
- According to the rather lighthearted guidelines of the National Hot Dog and Sausage Council, the one absolute rule for “dressing” a hot dog is to put the toppings directly on the hot dog, never on the bun. Survey the class to find how many follow this rule of hot dog etiquette. The council also recommends applying wet condiments such as mustard, ketchup, and chili first; then chunky dressings such as relish, onions, and sauerkraut; shredded cheese next; and finally, salt or any spices. Collect data to show how various people “dress” their hot dogs. Identify trends in your data and compare to the Hot Dog Council’s standards. For additional rather whimsical rules of etiquette, visit the Hot Dog Council’s website (see *Internet Connections*).
- In 2001, an estimated 26.8 million hot dogs were purchased in major league ballparks. Laid end to end, this many franks would reach from Dodger Stadium in Los Angeles to Tropicana Field in St. Petersburg, Florida. Using a hot dog as a non-standard unit of measure, determine the dimensions of your classroom in terms of hot dogs. Devise a plan to calculate the number of hot dogs required to line the boundaries of your school grounds. (Note: Not all hot dogs are equal, so you will need to establish the length of a “typical” frank.)
- Another way of portraying 26 million hot dogs is that they would circle the bases 36,000 times. What other ways can you think of to illustrate the combined length of 26 million franks?
- Hot dogs may be all beef, all pork, beef/pork, chicken, turkey, or some other combination. The label on the package tells exactly what the ingredients are. The ingredients are listed in order from the most to least amount used. Compare the ingredients of several different brands of franks. Try a taste test to determine which one different people prefer. Graph the results. Compare the costs of the different brands and rank according to how economical they are.
- In Spanish, a hot dog is *perrito caliente*. In Italian, it’s *caldo cane*. Compile a list of names for hot dogs in other languages. Ask friends and relatives, and use the Internet. (See *Internet Connections*.)

- Package labels give information regarding calories, fat, sodium, nutrients, and preserving agents. Compare several different brands of hot dogs. Compare hot dogs to other packaged processed meats such as pastrami, bologna, and salami, as well as other types of packaged foods.
- Build a solar cooker and use sun power to cook your hot dog. Various plans for cookers can be found on the Internet and in the AIMS book *Spring into Math and Science*.

## Literature Connections

For young readers:

Kessler, Ethel and Leonard. *Stan the Hot Dog Man*. HarperCollins Children's Books. New York. 1995. Stan starts a new business selling hot dogs and comes to the rescue during a snowstorm.

Saltzberg, Barney. *This Is a Great Place for a Hot Dog Stand*. Hyperion Books for Children. New York. 1995. Izzy makes difficult decisions about the location of his new business. He finally settles on a vacant lot where business thrives.

For all ages:

Aylesworth, Jim. *The Burger and the Hot Dog*. Atheneum Books for Young Readers. New York. 2001. Funny rhymes about familiar edibles with personality.

## Internet Connections

Hot Dog Council sites:

Trivia, statistics, history, recipes, photographs, and more

<http://www.hot-dog.org>

Calorie, fat, protein, and sodium calculations for franks with various fixings <http://www.hot-dog.org/feature.htm>

Description of the process of making hot dogs, with diagram

[http://www.hot-dog.org/hd\\_factory.htm](http://www.hot-dog.org/hd_factory.htm)

Information about National Hot Dog Month

<http://www.factmonster.com/spot/hotdog1.html>

Solar hot dog cooker

<http://www.energy.ca.gov/education/projects/projects-html/solardogs.html>

Recipes for various regional hot dog specialties and more

[\(Hot Dog Council site\)](http://www.hot-dog.org/recipes.htm)

<http://www.kraftfoods.com/html/main/recobox.html>

follow links: pork/beef entries (send) step 3 "hot dogs" get recipe

Hot dog construction zone (commercial site)

<http://www.kraftfoods.com/html/features/hotdog/wiener.html>

USDA Standards for hot dog production

<http://www.fsis.usda.gov/OA/pubs/focushotdog.htm>

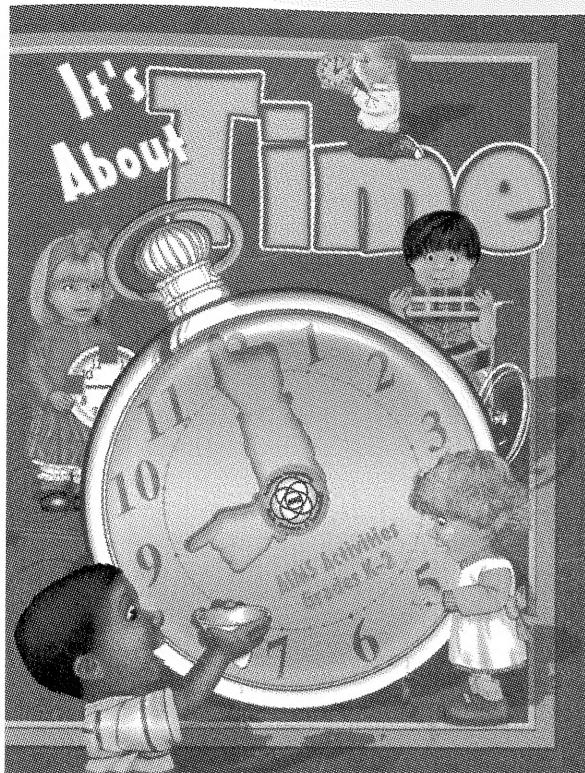
News release regarding the annual hot dog eating contest held in 2001

<http://www.cnn.com/2001/US/07/04/hotdog.contest/>

### Resources:

Fact sheets are available by request from the National Hot Dog and Sausage Council, Box 3556, Washington, DC, 20007; phone 703.841.2400; Fax: 703.527.0938. Topics are listed at <http://www.hot-dog.org/brochures.htm>

# New Books!



# New Books!

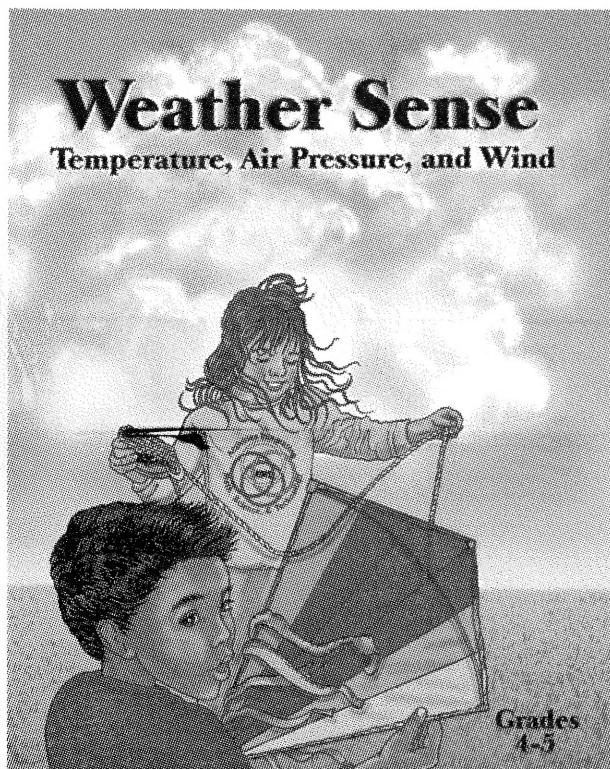
## **It's About Time—Grades K-2**

**It's About Time** is a series of investigations designed to build a conceptual understanding of time and its measurement. Experiences included have students sequencing events, measuring duration of time (long time/short time), and reading clocks. Time is read in hour, half-hour, five- and one-minute intervals. The activities invite students to use and even be a part of several model clocks as they build an understanding and a spatial memory of the number patterns that appear on both analog and digital clocks.

Since clock reading is a skill that is used in everyday life, being able to tell time is essential and needs to be mastered. Therefore, several activities have been designed for playful, intelligent practice that will help students become successful clock readers.

**Order No. 1113**

**\$18.95**



## **Weather Sense: Temperature, Air Pressure, and Wind—Grades 4-5**

We live in an ocean of air that influences our lives, both at work and at play. In this natural atmospheric laboratory, budding meteorologists observe how location affects temperature both in microclimates and macroclimates. A series of investigations leads them to discover the properties of air and, particularly, evidence of air pressure. Wind speed and direction are addressed, along with the safety issues of wind chill. Weather proverbs and the Beaufort Scale offer a historic point of view. Tying many of the weather components together is the station model, a visual model of weather conditions at a particular time and place.

Along with conceptual growth, students are engaged in discovering and controlling variables, constructing and using measuring tools, and making and interpreting maps and graphs. Learning is strengthened by interdisciplinary connections to math, literature, writing, geography, and technology.

**Order No. 1218**

**\$18.95**

# Table of Contents

## July/August 2002, Volume XVII, Number 1

### Features

9 Primarily Problem Solving  
*What's My Rule?*

24 Knowing and Caring about Numbers  
*The Multiplication Table*

58 The Teachable Moment  
*Hot Dogs*

### Departments

3 Isn't It Interesting...  
*Notions of Oceans*

29 Tinkering, Toys, and Teaching  
*Diverse Divers*

46 Puzzle Corner  
*Zoo-Knowlogy*

46 Maximizing Math  
*Zoo-Knowlogy*

### Activities

4 *Temperature Layers of the Ocean* 

12 *Glyph Hangers* 

18 *One Number Indivisible* 

34 *Patchwork Planting* 

39 *Reaching Up to the Sun* 

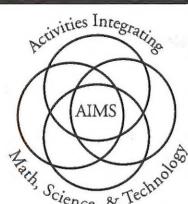
52 *Magnetic Manipulations* 

 = Primary Grade Activities

 = Middle Grade Activities

 = Upper Grade Activities

Web Page: <http://www.aimsedu.org/>



AIMS Education Foundation  
P. O. Box 8120  
Fresno, California 93747-8120

Non-Profit  
Organization  
U.S. Postage  
PAID  
AIMS  
Education  
Foundation